R&S®FSW-K10x (LTE Uplink)
LTE Uplink Measurement Application
User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 1.61 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)
- R&S®FSW43 (1312.8000K43)

The following firmware options are described:

- R&S FSW-K101 (LTE FDD UL) (1313.1551.02)
- R&S FSW-K105 (LTE TDD UL) (1313.1580.02)

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The following abbreviations are used throughout this manual: R&S®FSW is abbreviated as R&S FSW.

Contents

1 Welcome to the LTE Measurement Application....5
1.1 Starting the LTE Measurement Application....5
1.2 Understanding the Display Information....6
2 Measurements and Result Displays....8
2.1 I/Q Measurements....9
2.2 Frequency Sweep Measurements....21
3 Measurement Basics....24
3.1 Symbols and Variables....24
3.2 Overview....25
3.3 The LTE Uplink Analysis Measurement Application....25
4 Configuration....30
4.1 Configuration Overview....30
4.2 Configuring I/Q Measurements....32
4.3 Configuring Frequency Sweep Measurements....59
5 Analysis....61
5.1 Analyzing I/Q Measurements....61
5.2 Analyzing Frequency Sweep Measurements....64
6 Remote Control....66
6.1 Overview of Remote Command Suffixes....66
6.2 Introduction....66
6.3 Remote Commands to Select the LTE Application....70
6.4 Performing Measurements....74
6.5 Remote Commands to Read Trace Data....78
6.6 Remote Commands to Read Numeric Results....89
6.7 Remote Commands to Configure the Application....98
6.8 Analysis....128
6.9 General Window Commands....131
6.10 Working with Windows in the Display....131
List of Commands....138

Index.....142

1 Welcome to the LTE Measurement Application

The R&S FSW-K101 and -K105 are firmware applications that add functionality to perform measurements on LTE signals according to the 3GPP standard to the R&S FSW.

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S FSW User Manual. The latest version is available for download at the product homepage (http://www2.rohde-schwarz.com/product/FSW.html).

Installation

Find detailed installing instructions in the Getting Started or the release notes of the R&S FSW.

1.1 Starting the LTE Measurement Application

The LTE measurement application adds a new application to the R&S FSW.

To activate the application

1. Press the MODE key on the front panel of the R&S FSW.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FSW.

2. Select the "LTE" item.

   The R&S FSW opens a new measurement channel for the LTE measurement application.

LTE PC software and LTE measurement application

If you are using the EUTRA/LTE PC Software in combination with an R&S FSW, the "Mode" dialog box also contains a item for this software. It is labeled "LTE Software" and opens the PC software on the R&S FSW.

A comprehensive description of the functionality of this software is provided in a separate manual available for download on the internet.

The measurement is started immediately with the default settings. It can be configured in the "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu.

For more information see chapter 4, "Configuration", on page 30.

1.2 Understanding the Display Information

The following figure shows a measurement diagram during analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.

1 = Toolbar
2 = Channel bar
3 = Diagram header
4 = Result display
5 = Softkey bar
6 = Status bar

Channel bar information

In the LTE measurement application, the R&S FSW shows the following settings:

Table 1-1: Information displayed in the channel bar in the LTE measurement application

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Freq	Frequency
Mode	LTE standard
Cell ID	Cell identity
Capture Time	Signal length that has been captured
Frame Count	Number of frames that have been captured
Selected Slot	Slot considered in the signal analysis
Selected Subframe	Subframe considered in the signal analysis

In addition, the channel bar also displays information on instrument settings that affect the measurement results even though this is not immediately apparent from the display of the measured values (e.g. transducer or trigger settings). This information is displayed only when applicable for the current measurement. For details see the R&S FSW Getting Started manual.

Window title bar information

The information in the window title bar depends on the result display.

The "Constellation Diagram", for example, shows the number of points that have been measured.

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

Regarding the synchronization state, the application shows the following labels.

- Sync OK
  The synchronization was successful. The status bar is green.
- Sync Failed
  The synchronization was not successful. The status bar is red.
  There can be three different synchronization errors.
  - Sync Failed (Cyclic Prefix): The cyclic prefix correlation failed.
  - Sync Failed (P-SYNC): The P-SYNC correlation failed.
  - Sync Failed (S-SYNC): The S-SYNC correlation failed.

2 Measurements and Result Displays

The LTE measurement application measures and analyzes various aspects of an LTE signal.

It features several measurements and result displays. Measurements represent different ways of processing the captured data during the digital signal processing. Result displays are different representations of the measurement results. They may be diagrams that show the results as a graph or tables that show the results as numbers.

Selecting measurements

► Press the MEAS key.

The application opens a dialog box that contains several buttons.
Each button represents a set of result displays that thematically belong together and that have a particular display configuration. If these predefined display configurations do not suit your requirements you can add or remove result displays as you like. For more information about selecting result displays see "Selecting result displays" on page 8.

Depending on what button you select, the application changes the way the R&S FSW capture and processes the raw signal data.

- When you select "EVM" or "Time Alignment", the application processes the I/Q data of the signal. For more information on available I/Q result displays see chapter 2.1, "I/Q Measurements", on page 9.
  When you select one of the result displays available for I/Q measurements, you can combine the result displays available for I/Q measurements in any way.
- When you select "Channel Power ACLR" or "Spectrum Emission Mask", the application performs a frequency sweep. For more information see chapter 2.2, "Frequency Sweep Measurements", on page 21.
  When you select one of the frequency sweep measurements, you can combine the result displays available for the frequency sweep measurements in any way. Note that you can not display the ACLR and SEM at the same time.

Selecting result displays

► Select the icon in the toolbar or press the "Display Config" softkey in the "Measurement" menu.

The application enters the SmartGrid configuration mode.
For more information on the SmartGrid functionality see the R&S FSW Getting Started.

In the default state of the application, it shows several conventional result displays.

- Capture Memory
- EVM vs Carrier
- Power Spectrum

- Result Summary
- Constellation Diagram

From that predefined state, add and remove result displays as you like.

Performing measurements

By default, the application measures the signal continuously. In "Continuous Sweep" mode, the application captures and analyzes the data again and again. The amount of data depends on the capture time (I/Q measurements) or the sweep time (frequency sweep measurements). In "Single Sweep" mode, the application stops measuring after it has captured the data once. The amount of data again depends on the capture time or the sweep time.

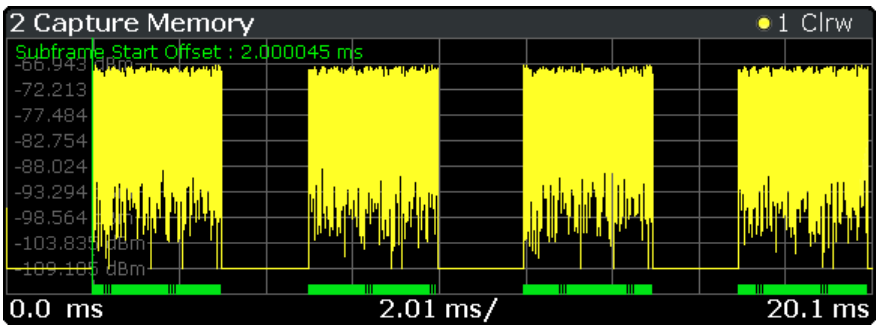
For more information see the documentation of the R&S FSW.

- I/Q Measurements....9
- Frequency Sweep Measurements....21

2.1 I/Q Measurements

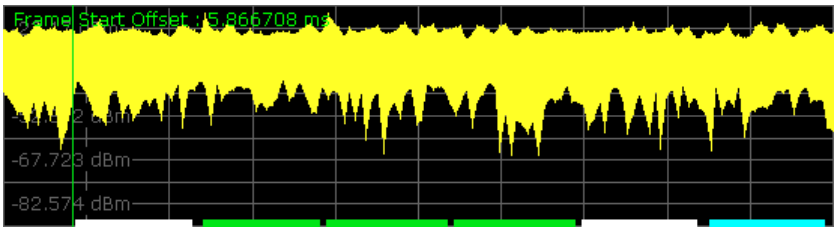
Capture Buffer....9
EVM vs Carrier....10
EVM vs Symbol....11
EVM vs Subframe....12
Power Spectrum....12
Inband Emission....13
Channel Flatness....14
Channel Flatness SRS....14
Channel Group Delay....15
Channel Flatness Difference....15
Constellation Diagram....16
CCDF....16
Allocation Summary....17
Bit Stream....17
Result Summary....18
Marker Table....21

Capture Buffer
The Capture Buffer result display shows the complete range of captured data for the last data capture. The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).



A green vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the diagram contains the "Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.



Remote command:
LAY:ADD ? '1',LEFT,CBUF
TRACe:DATA?
Querying the subframe start offset:
`FETCh:SUMMary:TFRame?` on page 96

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

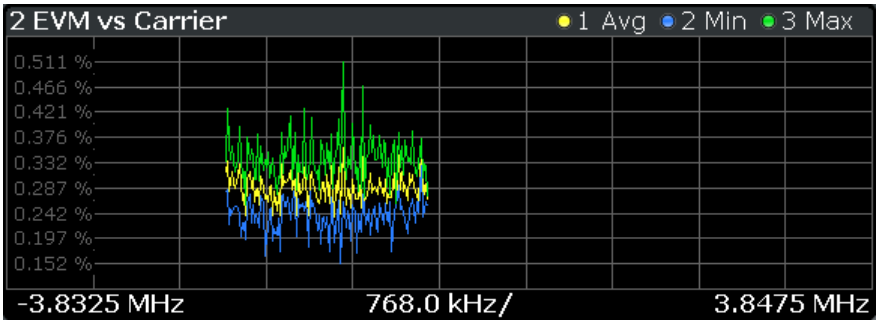
The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed slot in the capture buffer.

If you analyze all slots, the result display contains three traces.

- Average EVM
  This trace shows the subcarrier EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed slots.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the subcarrier EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 61

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
LAY:ADD ? '1',LEFT,EVCA
TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed slot.

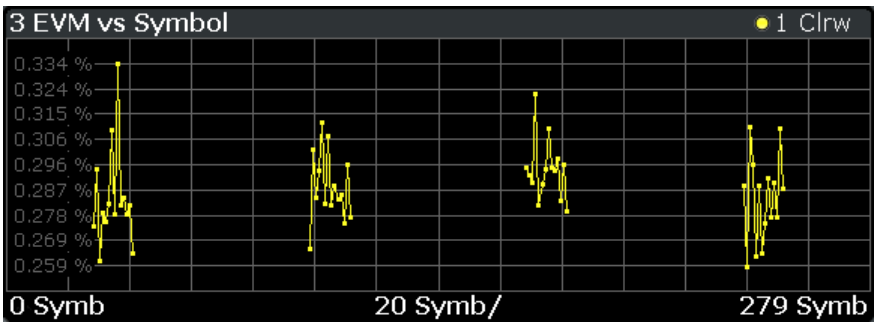
If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the OFDM symbol EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed slots.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the OFDM symbol EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 61

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSW could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit



Remote command:
LAY:ADD ? '1',LEFT,EVSY
TRACe:DATA?

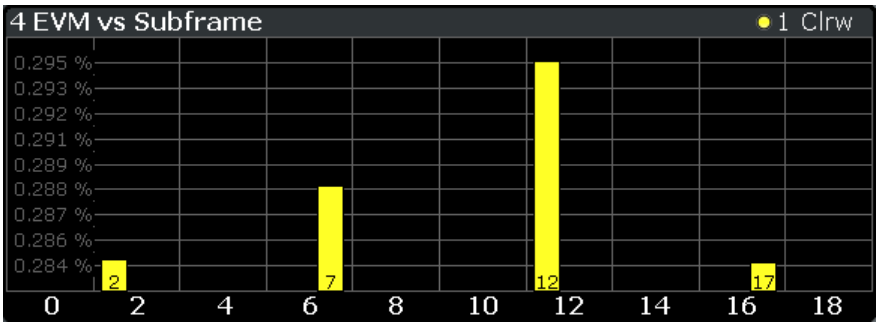
EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



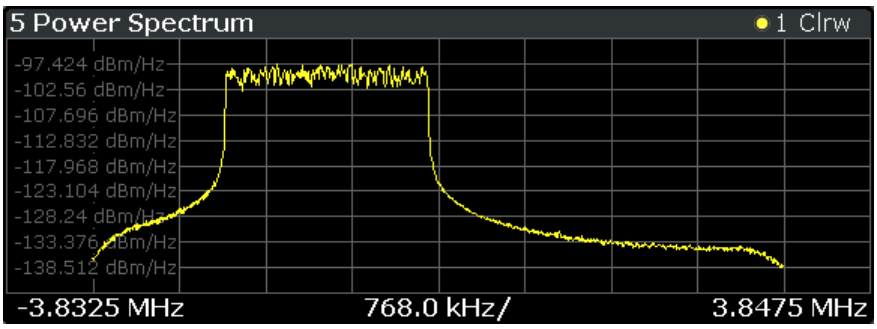
Remote command:
LAY:ADD ? '1',LEFT,EVSU
TRACe:DATA?

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 34.

The x-axis represents the frequency. On the y-axis the power level is plotted.



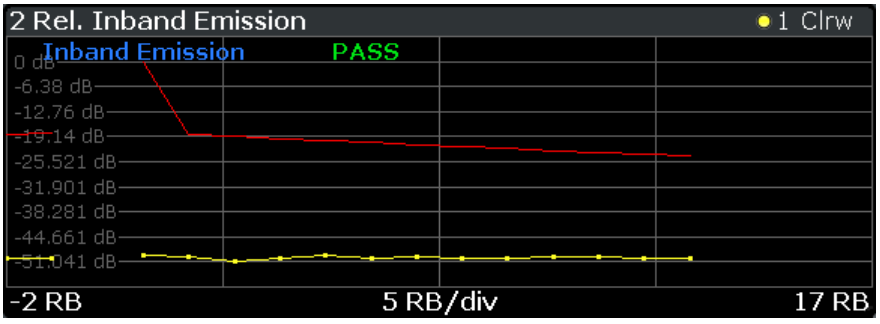
Remote command:
LAY:ADD ? '1',LEFT,PSPE
TRACe:DATA?

Inband Emission
Starts the Inband Emission result display.

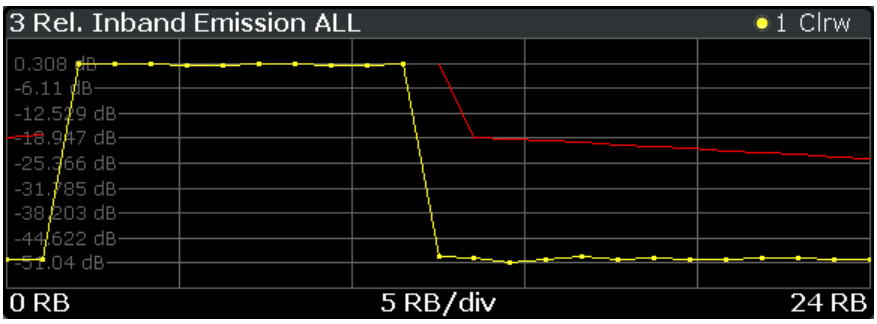
This result display shows the relative power of the unused resource blocks (yellow trace) and the inband emission limit lines (red trace) specified by the LTE standard document 3GPP TS36.101.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection.

Note that you have to select a specific subframe and slot to get valid measurement results.



You can also display the inband emissions for the allocated resource block in addition to the unused resource blocks when you select the Inband Emissions All result display.



Remote command:
LAY:ADD ? '1',LEFT,IE
LAY:ADD ? '1',LEFT,IEA
TRACe:DATA?

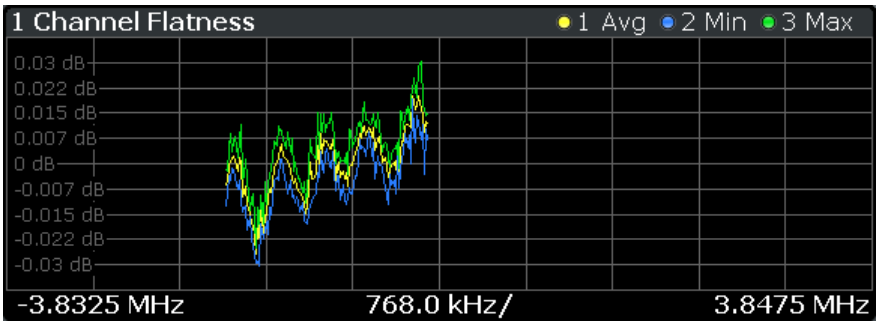
Channel Flatness
Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.

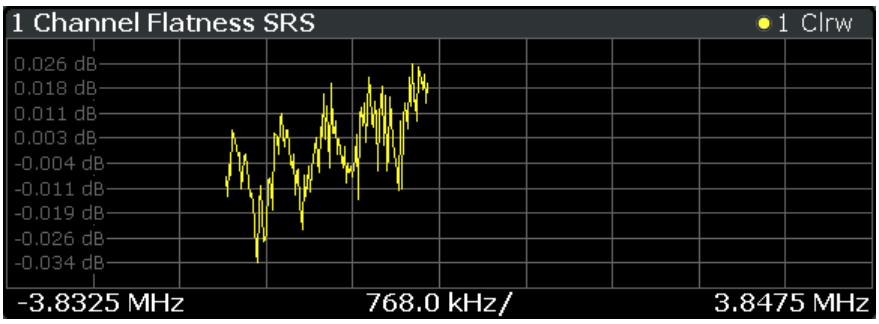


Note that the limit lines are only displayed if you match the Operating Band to the center frequency. Limits are defined for each operating band in the standard. The shape of the limit line is different when "Extreme Conditions" on page 37 are on.

Remote command:
LAY:ADD ? '1',LEFT,FLAT
TRACe:DATA?

Channel Flatness SRS
The Channel Flatness SRS display shows the amplitude of the channel transfer function based on the sounding reference signal.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The slot and subframe selection may be changed in the general settings.



Remote command:
LAY:ADD ? '1',LEFT,FSRS
TRACe:DATA

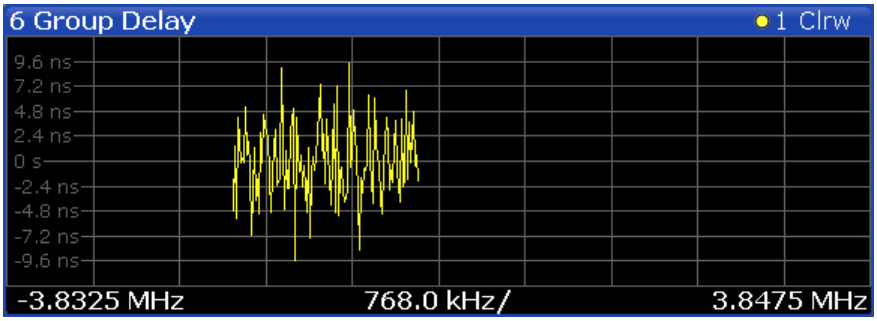
Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.



Remote command:
LAY:ADD ? '1',LEFT,GDEL
TRACe:DATA?

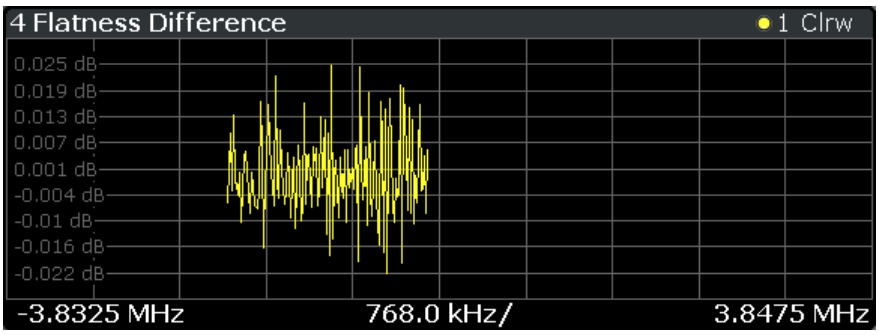
Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.

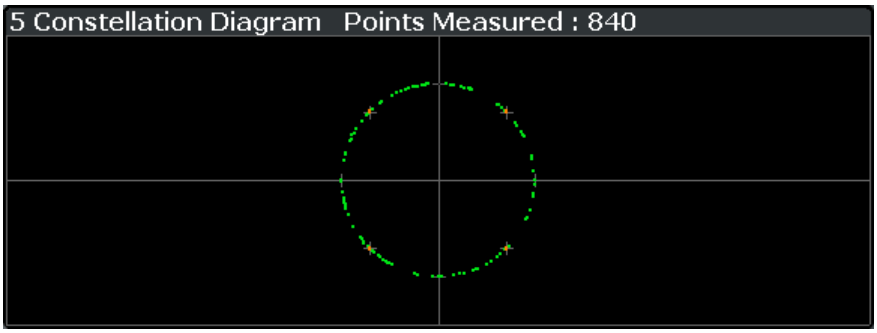


Remote command:
LAY:ADD ? '1',LEFT,FDIF
TRACe:DATA?

Constellation Diagram
Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.

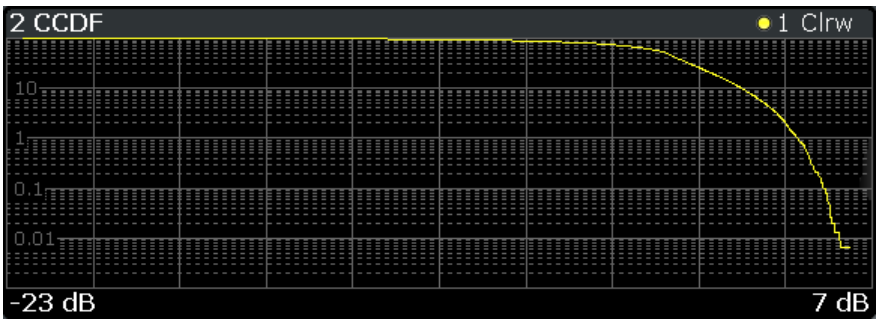


Remote command:
LAY:ADD ? '1',LEFT,CONS
TRACe:DATA?

CCDF
Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



Remote command:
LAY:ADD ? '1',LEFT,CCDF
TRACe:DATA?

Allocation Summary
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.

4 Allocation Summary

Sub-Frame	Allocation ID	No. of RBs	Offset RB	Modulation	Power [dBm]	EVM [%]
2	PUSCH	10	2	QPSK	-30.020	0.285
	DMRS PUSCH			CAZAC	-30.020	0.292
7	PUSCH	10	2	QPSK	-30.019	0.287
	DMRS PUSCH			CAZAC	-30.017	0.297

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Offset RB**
  Shows the resource block offset of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power**
  Shows the power of the allocation in dBm.
- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Remote command:
LAY:ADD ? '1',LEFT,ASUM
TRACe:DATA?

Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.

1 Bit Stream
Sub-Frame
Allocation ID
Code-word
Modulation
Symbol Index
Bit
2 PUSCH 1/1 QPSK 0 02 02 00 03 02 01 02
2 PUSCH 1/1 QPSK 16 01 01 02 00 00 00 03
2 PUSCH 1/1 QPSK 32 00 02 03 00 03 03 02
2 PUSCH 1/1 QPSK 48 00 02 01 02 03 02 02
2 PUSCH 1/1 QPSK 64 01 01 00 03 03 01 01
2 PUSCH 1/1 QPSK 80 00 02 01 03 03 03 03

The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Bit Stream**
  The actual bit stream.

Remote command:
LAY:ADD ? '1',LEFT,BSTR
TRACe:DATA?

Result Summary
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

SCPI command:

LAY:ADD ? '1',LEFT,RSUM

Contents of the result summary

4 Result Summary

Frame Results 30/30	Mean	Limit	Max	Min
EVM PUSCH QPSK (%)	0.30	17.50		
EVM PUSCH 16QAM (%)		12.50		
EVM DMRS PUSCH QPSK (%)	0.35	17.50		
EVM DMRS PUSCH 16QAM (%)		12.50		
EVM PUCCH (%)		17.50		
EVM DMRS PUCCH (%)		17.50		
Results for Selection	**Subframe(s) ALL**	**Slot(s) ALL**	**Frame Results 30/30**	
EVM All (%)	0.29		0.30	0.28
EVM Phys. Channel (%)	0.29		0.30	0.27
EVM Phys. Signal (%)	0.28		0.31	0.25
Frequency Error (Hz)	-26.65		-26.05	-27.29
Sampling Error (ppm)				
IQ Offset (dB)	-67.10		-63.11	-74.13
IQ Gain Imbalance (dB)				
IQ Quadrature Error (°)				
Power (dBm)	-30.02		-30.02	-30.02
Crest Factor (dB)	5.76		6.21	5.35

4 Result Summary

3GPP EVM Results	Mean	Limit	Max	Min
EVM PRACH (%)	0.22	17.50		
Results for Selection	**Preamble ALL**		**Preamble Count 2/2**	
EVM All (%)	0.22		0.22	0.22
Frequency Error (Hz)	-26.91		-26.77	-27.04
Sampling Error (ppm)				
IQ Offset (dB)	-127.79		-127.70	-127.88
IQ Gain Imbalance (dB)				
IQ Quadrature Error (°)				
Power (dBm)	-26.59		-26.59	-26.59
Crest Factor (dB)	4.50		4.51	4.49

The table is split in two parts. The first part shows results that refer to the complete frame. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

Note that the contents of the table depends on whether you are measuring in PUCCH/ PUSCH or PRACH analysis mode. For more information see "Analysis Mode" on page 57.

In addition to the red font, the application also puts a red star (* 25.60) in front of failed results.

- **EVM PUSCH QPSK**
  Shows the EVM for all QPSK-modulated resource elements of the PUSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:USQP[:AVERage]?` on page 91
- **EVM PUSCH 16QAM**
  Shows the EVM for all 16QAM-modulated resource elements of the PUSCH channel in the analyzed frame.
  `FETCh:SUMMary:EVM:USST[:AVERage]?` on page 92
- **EVM DRMS PUSCH QPSK**
  Shows the EVM of all DMRS resource elements with QPSK modulation of the PUSCH in the analyzed frame.
  `FETCh:SUMMary:EVM:SDQP[:AVERage]?` on page 90
- **EVM DRMS PUSCH 16QAM**

Shows the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH in the analyzed frame.
FETCh:SUMMary:EVM:SDST[:AVERage]? on page 90

- **EVM PUCCH**
  Shows the EVM of all resource elements of the PUCCH channel in the analyzed frame.
  FETCh:SUMMary:EVM:UCCH[:AVERage]? on page 91
- **EVM DMRS PUCCH**
  Shows the EVM of all DMRS resource elements of the PUCCH channel in the analyzed frame.
  FETCh:SUMMary:EVM:UCCD[:AVERage]? on page 90
- **EVM PRACH**
  Shows the EVM of all resource elements of the PRACH channel in the analyzed frame.
  FETCh:SUMMary:EVM:UPRA[:AVERage]? on page 91

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the slots.

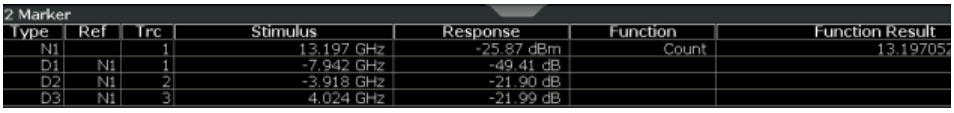
The header row of the table contains information about the selection you have made (like the subframe).

- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  FETCh:SUMMary:EVM[:ALL][:AVERage]? on page 93
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PCHannel[:AVERage]? on page 93
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PSIGnal[:AVERage]? on page 93
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  FETCh:SUMMary:FERRor[:AVERage]? on page 94
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  FETCh:SUMMary:SERRor[:AVERage]? on page 96
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  FETCh:SUMMary:IQOFfset[:AVERage]? on page 95
- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  FETCh:SUMMary:GIMBalance[:AVERage]? on page 94
- **I/Q Quadrature Error**
  Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.

FETCh:SUMMary:QUADerror[:AVERage]? on page 95

- **Power**
  Shows the average time domain power of the analyzed signal.
  FETCh:SUMMary:POWer[:AVERage]? on page 95
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  FETCh:SUMMary:CREStf[:AVERage]? on page 92

Marker Table
Displays a table with the current marker values for the active markers.


2 Marker
Type Ref Trc Stimulus Response Function Function Result
N1 1 13.197 GHz -25.87 dBm Count 13.19705
D1 N1 1 -7.942 GHz -49.41 dB
D2 N1 2 -3.918 GHz -21.90 dB
D3 N1 3 4.024 GHz -21.99 dB

Remote command:
LAY:ADD? '1',RIGH, MTAB, see LAYout:ADD[:WINDow]? on page 132
Results:
CALCulate<n>:MARKer<m>:X on page 97
CALCulate<n>:MARKer<m>:Y? on page 97

2.2 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

ACLR.....21
Spectrum Mask.....22

ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The ACLR measurement analyzes the power of the transmission (TX) channel and the power of the two neighboring channels (adjacent channels) to the left and right of the TX channel. Thus, the ACLR measurement provides information about the power in the adjacent channels as well as the leakage into these adjacent channels.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.

By default the ACLR settings are based on the selected LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and, if required, customize the channel setup to your needs. For more information see the documentation of the R&S FSW.

The power for the TX channel is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel.

In addition, the ACLR measurement results are also tested against the limits defined by 3GPP. In the diagram, the limits are represented by horizontal red lines.

ACLR table

A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

Remote command:
Selection:
CONF:MEAS ACLR
Reading results:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?
on page 88
TRACe:DATA?

Spectrum Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSW puts a label to the limit line to indicate whether the limit check passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.

A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**

Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.

- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

Remote command:
CONF:MEAS ESP
TRACe:DATA?

3 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

- Symbols and Variables....24
- Overview....25
- The LTE Uplink Analysis Measurement Application....25

3.1 Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k}\hat{a}_{l,k}$	data symbol (actual, decided)
$A_{l,k}$	data symbol after DFT-precoding
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	SC-FDMA symbol index
N_{DS}	number of SC-FDMA data symbols
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{TX}	number of allocated subcarriers
$N_{k,l}$	noise sample
n	index of modulated QAM symbol before DFT precoding
Φ_l	common phase error
r_i	received sample in the time domain
$R'_{k,l}$	uncompensated received sample in the frequency domain

$r_{n,l}$	equalized received symbols of measurement path after IDFT
T	duration of the useful part of an SC-FDMA symbol
T_g	duration of the guard interval
T_s	total duration of SC-FDMA symbol

3.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.

The contents of this chapter are structered like the DSP.

3.3 The LTE Uplink Analysis Measurement Application

The block diagram in figure 3-1 shows the general structure of the LTE uplink measurement application from the capture buffer containing the I/Q data up to the actual analysis block.

After synchronization a fully compensated signal is produced in the reference path (purple) which is subsequently passed to the equalizer. An IDFT of the equalized symbols yields observations for the QAM transmit symbols $a_{n,l}$ from which the data estimates $\hat{a}_{n,l}$ are obtained via hard decision. Likewise a user defined compensation as well as equalization is carried out in the measurement path (cyan) and after an IDFT the observations of the QAM transmit symbols are provided. Accordingly, the measurement path might still contain impairments which are compensated in the reference path. The symbols of both signal processing paths form the basis for the analysis.

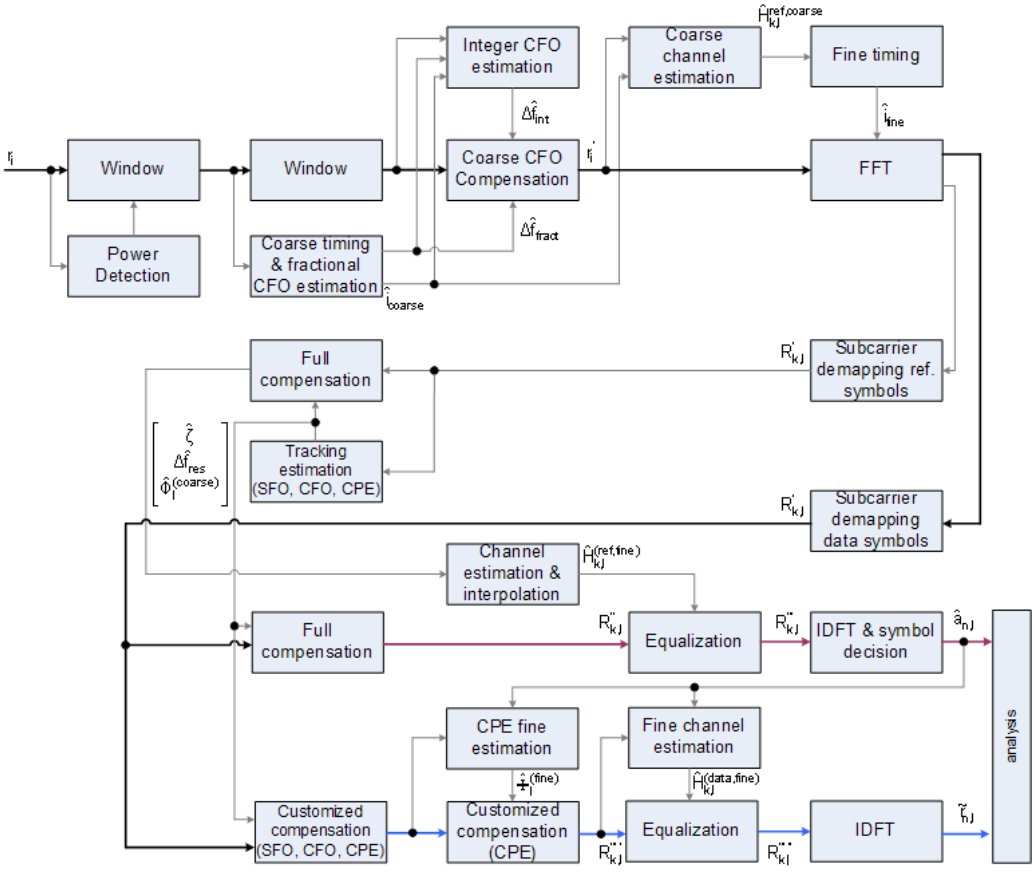


Fig. 3-1: Block diagram for the LTE UL measurement application

3.3.1 Synchronization

In a first step the areas of sufficient power are identified within the captured I/Q data stream which consists of the receive samples r_i. For each area of sufficient power, the analyzer synchronizes on subframes of the uplink generic frame structure [3]. After this coarse timing estimation, the fractional part as well as the integer part of the carrier frequency offset (CFO) are estimated and compensated. In order to obtain an OFDM demodulation via FFT of length N_{FFT} that is not corrupted by ISI, a fine timing is established which refines the coarse timing estimate.

A phase tracking based on the reference SC-FDMA symbols is performed in the frequency domain. The corresponding tracking estimation block provides estimates for

- the relative sampling frequency offset ζ
- the residual carrier frequency offset Δf_{res}
- the common phase error Φ_l

According to references [7] and [8], the uncompensated samples $R'_{k,l}$ in the DFT-precoded domain can be stated as

$$R'_{k,l} = A_{k,l} \cdot H_{k,l} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{k,l}$$

(3 - 1)

with

- the DFT precoded data symbol $A_{k,l}$ on subcarrier k at SC-FDMA symbol l,
- the channel transfer function $H_{k,l}$,
- the number of Nyquist samples N_S within the total duration T_S,
- the duration of the useful part of the SC-FDMA symbol $T=T_S-T_g$
- the independent and Gaussian distributed noise sample $N_{k,l}$

Within one SC-FDMA symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $R'_{k,l}$ completely in the reference path and according to the user settings in the measurement path. Thus the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decoded the data symbols in the reference path, an additional data-aided phase tracking can be utilized to refine the common phase error estimation.

3.3.2 Analysis

The analysis block of the EUTRA/LTE uplink measurement application allows to compute a variety of measurement variables.

EVM

The most important variable is the error vector magnitude which is defined as

$$EVM_{l,k} = \frac{\left|\tilde{r}_{n,l} - \hat{a}_{n,l}\right|}{\sqrt{E\left\{\left|a_{n,l}\right|^2\right\}}}$$

(3 - 2)

for QAM symbol n before precoding and SC-FDMA symbol l. Since the normalized average power of all possible constellations is 1, the equation can be simplified to

$$EVM_{n,l} = \left|\tilde{r}_{n,l} - \hat{a}_{n,l}\right|$$

(3 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{DS} N_{TX}} \sum_{l=0}^{N_{LB}-1} \sum_{n=0}^{N_{TX}-1} EVM_{n,l}^2}$$

(3 - 4)

for N_{DS} SC-FDMA data symbols and the N_{TX} allocated subcarriers.

I/Q imbalance

The I/Q imbalance contained in the continuous received signal r(t) can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(3 - 5)

where s(t) is the transmit signal and I and Q are the weighting factors describing the I/Q imbalance. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(3 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(3 - 7)

based on the complex-valued estimate $\Delta\hat{Q}$.

Basic in-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The relative in-band emissions are given by

$$Emissions_{relative}(\Delta_{RB}) = \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_S| \cdot N_{RB}} \sum_{t \in T_S} \sum_{c}^{c+12 \cdot N_{RB}-1} |Y(t,f)|^2}$$

(3 - 8)

where T_S is a set $|T_S|$ of SC-FDMA symbols with the considered modulation scheme being active within the measurement period, Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. Δ_{RB}=1 or Δ_{RB}=-1 for the first adjacent RB), c is the lower edge of the allocated BW, and Y(t,f) is the frequency domain signal evaluated for in-band emissions. N_{RB} is the number of allocated RBs .

The basic in-band emissions measurement interval is defined over one slot in the time domain.

Other measurement variables

Without going into detail, the EUTRA/LTE uplink measurement application additionally provides the following results:

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

4 Configuration

LTE measurements require a special application on the R&S FSW, which you activate using the MODE key on the front panel.

When you activate a measurement channel in the LTE application, a measurement for the input signal is started automatically with the default configuration. The "LTE" menu is displayed and provides access to the most important configuration functions.

Automatic refresh of preview and visualization in dialog boxes after configuration changes

The R&S FSW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before accepting the changes.

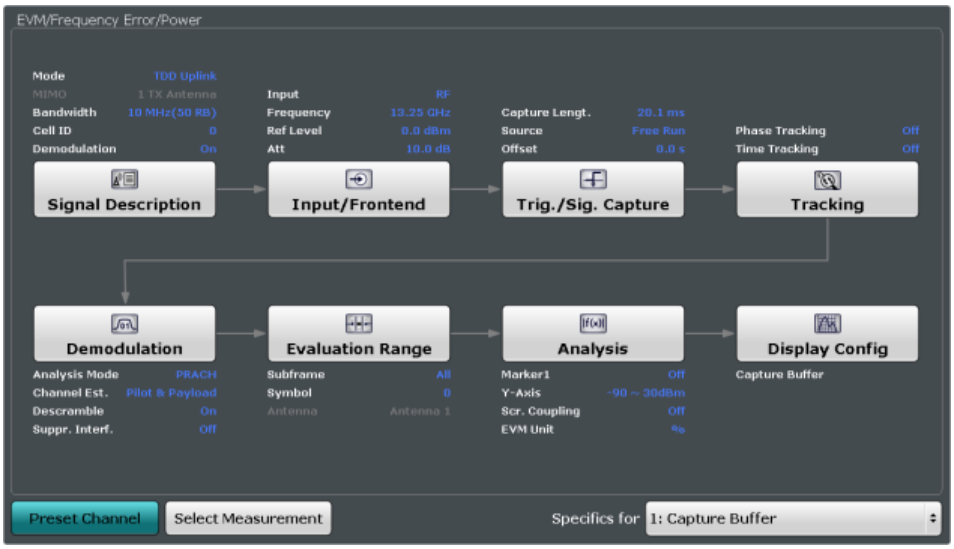
Unavailable hardkeys

Note that the SPAN, BW, TRACE, LINES and MKR FUNC keys have no contents and no function in the LTE application.

- Configuration Overview.....30
- Configuring I/Q Measurements.....32
- Configuring Frequency Sweep Measurements.....59

4.1 Configuration Overview

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See chapter 4.2.1.1, "Signal Description", on page 32.
2. Input / Frontend
   See chapter 4.2.2, "Input / Frontend", on page 50.
3. Trigger / Signal Capture
   See chapter 4.2.3, "Signal Capture", on page 54.
4. Tracking
   See chapter 4.2.4, "Tracking", on page 56.
5. Demodulation
   see chapter 4.2.5, "Signal Demodulation", on page 57.
6. Evaluation Range
   See chapter 5.1.1, "Evaluation Range", on page 61.
7. Analysis
   See chapter 5, "Analysis", on page 61.
8. Display Configuration
   See chapter 2.1, "I/Q Measurements", on page 9.

In addition, the dialog box provides the "Select Measurement" button that serves as a shortcut to select the measurement type.

Note that the "Overview" dialog box for frequency sweep measurement is similar to that of the Spectrum mode.

For more information refer to the documentation of the R&S FSW.

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the measurement channel tab) to change a specific setting.

Preset Channel
Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key on the front panel restores all measurements **in all measurement channels** on the R&S FSW to their default values!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 99

Specifics for
The measurement channel may contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

4.2 Configuring I/Q Measurements

- Defining the Signal Characteristics....32
- Input / Frontend....50
- Signal Capture....54
- Tracking....56
- Signal Demodulation....57

4.2.1 Defining the Signal Characteristics

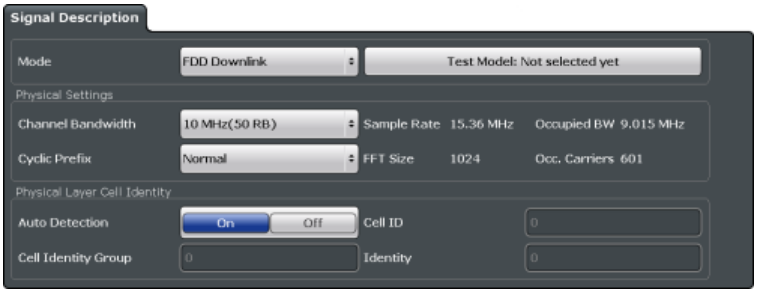
Note

Note that MIMO functionality for uplink signals is not supported yet.

- Signal Description....32
- Configuring Subframes....37
- Advanced Uplink Settings....39

4.2.1.1 Signal Description

The general signal characteristics contain settings to describe the general physical attributes of the signal.



Selecting the LTE Mode....33
Using Test Models....33
Channel Bandwidth / Number of Resource Blocks....34
Cyclic Prefix....35
Configuring TDD Frames....35
Configuring the Physical Layer Cell Identity....36
Operating Band Index....37
Extreme Conditions....37

Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the configuration of the R&S FSW.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

The application shows the currently selected LTE mode (including the bandwidth) in the channel bar.

Remote command:

`CONFigure[:LTE]:LDIRection` on page 100

`CONFigure[:LTE]:DUPLexing` on page 99

Using Test Models

Test models are descriptions of LTE signals that you can use for particular test scenarios.

The "Test Models" dialog box contains functionality to select, manage and create test models.

- "Specification"
  The "Specification" tab contains predefined test models as defined by 3GPP.
  Predefined test models are supported in downlink mode.
- "User Defined"
  The "User Defined" tab contains functionality to manage custom test models.
  Custom test models are supported in downlink and uplink mode.
  To create a custom test model, describe a signal as required and then save it via the "Test Models" dialog box.
  Here, you can also restore custom test models and delete ones you do not need anymore.

Predefined test models (E-TM)

In case of downlink signals, the 3GPP standard (TS 36.141) already defines several EUTRA test models (E-TM) for specific test scenarios. These test models are split into three main groups (E-TM1, E-TM2 and E-TM3) and are defined by the following characteristics.

- single antenna port, single code word, single layer and no precoding
- duration of one frame
- normal cyclic prefix
- localized virtual resource blocks, no intra-subframe hopping for PDSCH
- UE-specific reference signal not used

The data content of the physical channels and signals are defined in the 3GPP standard. Each E-TM is defined for for all bandwidths defined in the standard (1.4 MHz / 3 MHz / 5 MHz / 10 MHz / 15 MHz / 20 MHz).

Table 4-1: Test scenarios for E-TM as defined by 3GPP

- **E-TM1.1**
  BS output power
  Unwanted emissions
  Transmitter intermodulation
  RS absolute accuracy
- **E-TM1.2**
  ACLR
  Operating band unwanted emissions
- **E-TM2**
  Total power dynamic range (lower OFDM symbol power limit at min. power)
  EVM of single 64QAM PRB allocation (at min. power)
  Frequency error (at min. power)
- **E-TM3.1**
  Output power dynamics
  Transmitted signal quality (frequency error and EVM for 64QAM modulation at max. power)
- **E-TM3.2**
  Transmitted signal quality
  – Frequency error
  – EVM for 16QAM modulation
- **E-TM3.3**
  Transmitted signal quality
  – Frequency error
  – EVM for QPSK modulation

Channel Bandwidth / Number of Resource Blocks

Specifies the channel bandwidth and number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. Currently, the LTE standard recommends six bandwidths (see table below).

The R&S FSW also calculates the FFT size, sampling rate, occupied bandwidth and occupied carriers from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	30.72	30.72
FFT Size	128	256	512	1024	2048	2048

The application shows the currently selected LTE mode (including the bandwidth) in the channel bar.

Remote command:
CONFigure[:LTE]:UL:BW on page 100

Cyclic Prefix
The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

Remote command:
CONFigure[:LTE]:UL:CYCPrefix on page 100

Configuring TDD Frames
TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

Remote command:
Subframe
`CONFigure[:LTE]:UL:TDD:UDConf` on page 102
Special Subframe
`CONFigure[:LTE]:UL:TDD:SPSC` on page 102

Configuring the Physical Layer Cell Identity
The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the R&S FSW automatically updates the other two.

The Cell ID determines

- the reference signal grouping hopping pattern
- the reference signal sequence hopping
- the PUSCH demodulation reference signal pseudo-random sequence
- the cyclic shifts for PUCCH formats 1/1a/1b and sequences for PUCCH formats 2/2a/2b
- the pseudo-random sequence used for scrambling
- the pseudo-random sequence used for type 2 PUSCH frequency hopping

The application shows the currently selected cell ID in the channel bar.

Remote command:
Cell ID:
`CONFigure[:LTE]:UL:PLC:CID` on page 101
Cell Identity Group:
`CONFigure[:LTE]:UL:PLC:CIDGroup` on page 101
Identity
`CONFigure[:LTE]:UL:PLC:PLID` on page 101

Operating Band Index
Selects one of the 40 operating bands for spectrum flatness measurements as defined in TS 36.101.

The operating band defines the frequency band and the dedicated duplex mode.

Remote command:
`[SENSe][:LTE]:SFLatness:OBANd` on page 102

Extreme Conditions
Turns extreme conditions on and off.

If you turn the extreme conditions on, the software will modify the limit lines for the limit check of the spectral flatness measurement.

Remote command:
`[SENSe][:LTE]:SFLatness:ECONditions` on page 102

4.2.1.2 Configuring Subframes

An LTE frame consists of 10 subframes. Each individual subframe may have a different resource block configuration. This configuration is shown in the "Subframe Configuration Table".

The application supports two ways to determine the characteristics of each subframe.

- Automatic demodulation of the channel configuration and detection of the subframe characteristics.
  In case of automatic demodulation, the contents of the table are determined according to the signal currently evaluated.
  For more information see "Auto Demodulation" on page 38.
- Custom configuration of the configuration of each subframe.
  In case of manual configuration, you can customize the table according to the signal that you expect. The signal is demodulated even if the signal does not fit the decription in the table or, in case of Physical Detection, only if the frame fits the description in the table.

Frame number offset

A frame number offset is also supported. The frame number offset assigns a number to the demodulated frame in order to identify it in a series of transmitted (and captured) frames. You can define this frame in the Global Settings.

Subframe Configuration Table....38
Auto Demodulation....38
Subframe Configuration Detection....39

Subframe Configuration Table
The "Subframe Configuration Table" contains the characteristics for each subframe. The software supports a maximum uplink LTE frame size of 10 subframes. The subframe number in the table depends on the number of "Configurable Subframes" that you have defined or that have been detected in case of automatic demodulation.

Each row of the table represents one subframe.

For each subframe you can define the following characteristics.

- Subframe
  Shows the number of a subframe.
  Note that, depending on the TDD configuration, some subframes may not be available for editing. The R&S FSW labels those subframes "(not used)".
- Enable PUCCH
  Turns the PUCCH in the corresponding subframe on and off.
  If you enable PUCCH, the application automatically turns PUSCH off. "Modulation", "Number of RBs" and "Offset RB" are unavailable for that subframe. If you disable PUCCH, the application automatically turns PUSCH on. "Modulation", "Number of RBs" and "Offset RB" become available
- Modulation
  Selects the modulation scheme for the corresponding PUSCH allocation.
  The modulation scheme is either QPSK, 16QAM or 64QAM.
- Number of RB
  Sets the number of resource blocks the PUSCH allocation covers. The number of resource blocks defines the size or bandwidth of the PUSCH allocation.
- Offset RB
  Sets the resource block at which the PUSCH allocation begins.
  Make sure not to allocate PUSCH allocations into regions reserved for PUCCH allocations.

Remote command:
Configurable subframes:
`CONFigure[:LTE]:UL:CSUBframes` on page 103
Frame number offset:
`CONFigure[:LTE]:UL:SFNO` on page 105
Enable PUCCH:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT` on page 103
Modulation:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation` on page 103
Number of RB:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount` on page 104
Offset RB:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset` on page 104

Auto Demodulation
Turns automatic demodulation on and off.

If active, the R&S FSW automatically detects the characteristics of each subframe in the signal (resource allocation of the signal).

Two methods of detection are supported:

- Auto Demodulation, **DMRS Auto Detection (Off)**
  This method automatically determines the characteristics for each subframe as shown in the Subframe Configuration Table.
  The table is populated accordingly.
- Subframe Configuration & DMRS
  Auto Demodulation, **DMRS Auto Detection (On)**
  This method automatically detects the PUSCH and SRS (i.e. no PUCCH can be detected).
  To determine these characteristics, the software detects the CAZAC base parameters. Thus, the DMRS configuration parameters are not required for the synchronization and therefore are not available using this method.
  Note however that it is not possible to derive the DMRS configuration parameters from the CAZAC base parameters so that the disabled DMRS configuration parameters do not reflect the current parameters used for the synchronization. Also note that it can happen that the software successfully synchronizes on non-3GPP signals without a warning.

Automatic demodulation is not available if the Suppressed Interference Synchronization is active.

Remote command:
`[SENSe][:LTE]:UL:DEMod:ACON` on page 104

Subframe Configuration Detection
Turns the detection of the subframe configuration on and off.

Upon activation, the software compares the current demodulated LTE frame to the subframe configuration you have set. Only if the signal is consistent with the configuration, the software will further analyze the LTE frame.

If inactive, the software analyzes the signal even if it is not consistent with the current subframe configuration.

Subframe configuration detection is available if you are using a Predefined subframe configuration.

Remote command:
`[SENSe][:LTE]:UL:FORMat:SCD` on page 105

4.2.1.3 Advanced Uplink Settings

The uplink advanced signal characteristics contain settings that describe the detailed structure of a uplink LTE signal.

- Defining Global Signal Characteristics....40
- Configuring the Demodulation Reference Signal....40
- Configuring the Sounding Reference Signal....42
- Defining the PUSCH Structure....45
- Defining the PUCCH Structure....46
- Defining the PRACH Structure....48

Defining Global Signal Characteristics

The global settings contain settings that apply to the complete signal.

The global signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.

Frame Number Offset....40
UE ID/n_RNTI....40

Frame Number Offset
Defines a frame number offset for the analyzed frame.

The frame number offset assigns a number to the demodulated frame in order to identify it in a series of transmitted (and captured) frames.

Remote command:
`CONFigure[:LTE]:UL:SFNO` on page 105

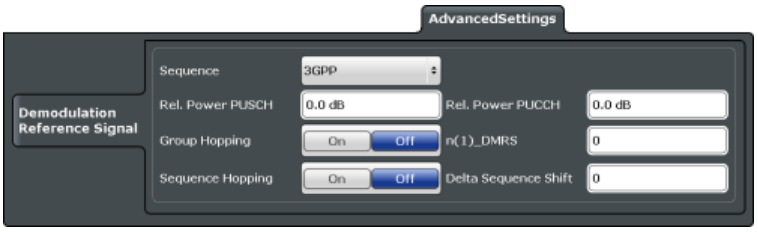
UE ID/n_RNTI
Sets the radio network temporary identifier (RNTI) of the UE.

Remote command:
`CONFigure[:LTE]:UL:UEID` on page 105

Configuring the Demodulation Reference Signal

The demodulation reference signal (DRS) settings contain settings that define the physical attributes and structure of the demodulation reference signal. This reference signal helps to demodulate the PUSCH.

The demodulation reference signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Sequence....41
Relative Power PUSCH....41
Group Hopping....41
Sequence Hopping....41
Relative Power PUCCH....41
n(1)_DMRS....42
Delta Sequence Shift....42

Sequence
Selects the definition the demodulation reference signal is based on.

"3GPP" The structure of the DRS is based on the 3GPP standard.
If you are using a DRS based on 3GPP, you have to set all parameters in the "Demodulation Reference Signal" settings group. They have to be the same as those of the signal generator.

Relative Power PUSCH
Defines the power of the DMRS relative to the power level of the PUSCH allocation in the corresponding subframe (P_{DMRS_Offset}).

The effective power level of the DMRS depends on the allocation of the subframe and is calculated as follows.

$P_{DMRS} = P_{UE} + P_{PUSCH} + P_{DMRS\_Offset}$

The relative power of the DMRS is applied to all subframes.

The power of the PUSCH (P_{PUSCH}) may be different in each subframe.

Remote command:
`CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer` on page 106

Group Hopping
Turns group hopping for the demodulation reference signal on and off.

The group hopping pattern is based on 17 hopping patterns and 30 sequence shift patterns. It is generated by a pseudo-random sequence generator.

If on, PUSCH and PUCCH use the same group hopping pattern.

Remote command:
`CONFigure[:LTE]:UL:DRS:GRPHopping` on page 106

Sequence Hopping
Turns sequence hopping for the uplink demodulation reference signal on and off.

Sequence hopping is generated by a pseudo-random sequence generator.

Remote command:
`CONFigure[:LTE]:UL:DRS:SEQHopping` on page 106

Relative Power PUCCH
Defines the power of the DMRS relative to the power level of the PUSCH allocation in the corresponding subframe (P_{DMRS_Offset}).

The effective power level of the DMRS depends on the allocation of the subframe and is calculated as follows.

$P_{DMRS} = P_{UE} + P_{PUCCH} + P_{DMRS\_Offset}$

The relative power of the DMRS is applied to all subframes.

The power of the PUSCH (P_{PUSCH}) may be different in each subframe.

Remote command:
`CONFigure[:LTE]:UL:DRS:PUCCh:POWer` on page 106

n(1)_DMRS
The n_DMRS parameter can be found in 3GPP TS36.211 V8.5.0, 5.5.2.1.1 Reference signal sequence.

Remote command:
`CONFigure[:LTE]:UL:DRS:NDMRs` on page 107

Delta Sequence Shift
Defines the delta sequence shift Δ_{SS}.

The standard defines a sequence shift pattern f_{ss} for the PUCCH. The corresponding sequence shift pattern for the PUSCH is a function of f_{ss}^{PUCCH} and the delta sequence shift.

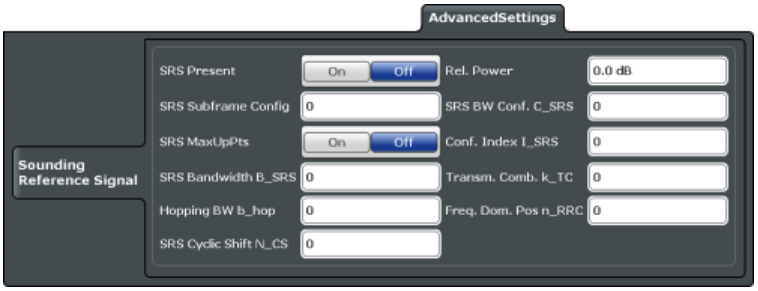
For more information refer to 3GPP TS 36.211, chapter 5.5.1.3 "Group Hopping".

Remote command:
`CONFigure[:LTE]:UL:DRS:DSSHift` on page 107

Configuring the Sounding Reference Signal

The sounding reference signal (SRS) settings contain settings that define the physical attributes and structure of the sounding reference signal.

The sounding reference signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Present....42
SRS Subframe Conf....43
SRS MaxUpPts....43
SRS Bandwidth B_SRS....43
Hopping BW b_hop....43
SRS Cyclic Shift N_CS....44
SRS Rel Power....44
SRS BW Conf. C_SRS....44
Conf. Index I_SRS....44
Transm. Comb. k_TC....44
Freq. Domain Pos. n_RRC....44

Present
Includes or excludes the sounding reference signal (SRS) from the test setup.

Remote command:
`CONFigure[:LTE]:UL:SRS:STAT` on page 109

SRS Subframe Conf.
Defines the subframe configuration of the SRS.

The subframe configuration of the SRS is specific to a cell. The UE sends a shortened PUCCH/PUSCH in these subframes, regardless of whether the UE is configured to send an SRS in the corresponding subframe or not.

Remote command:
`CONFigure[:LTE]:UL:SRS:SUConfig` on page 110

SRS MaxUpPts
Turns the parameter srs_MaxUpPts on and off.

srs_MaxUpPts controls the SRS transmission in the UpPTS field in TDD systems. If on, the SRS is transmitted in a frequency range of the UpPTS field that does not overlap with resources reserved for PRACH preamble 4 transmissions.

To avoid an overlap, the number of SRS resource blocks otherwise determined by C_SRS and B_SRS is reconfigured.

Remote command:
`CONFigure[:LTE]:UL:SRS:MUPT` on page 109

SRS Bandwidth B_SRS
Defines the parameter B_{SRS}.

B_{SRS} is a UE specific parameter that defines the bandwidth of the SRS. The SRS either spans the entire frequency bandwidth or uses frequency hopping when several narrowband SRS cover the same total bandwidth.

The standard defines up to four bandwidths for the SRS. The most narrow SRS bandwidth (B_{SRS} = 3) spans four resource blocks and is available for all channel bandwidths. The other three values of B_{SRS} define more wideband SRS bandwidths. Their availability depends on the channel bandwidth.

The availability of SRS bandwidths additionally depends on the bandwidth configuration of the SRS (C_{SRS}).

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:BSRS` on page 108

Hopping BW b_hop
Defines the parameter b_{hop}.

b_{hop} is a UE specific parameter that defines the frequency hopping bandwidth. SRS frequency hopping is active if $b_{hop} < B_{SRS}$.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:BHOP` on page 107

SRS Cyclic Shift N_CS
Defines the cyclic shift (n_{CS}) used for the generation of the SRS CAZAC sequence.

Because the different shifts of the same Zadoff-Chu sequence are orthogonal to each other, applying different SRS cyclic shifts can be used to schedule different UE to simultaneously transmit their SRS.

Remote command:
`CONFigure[:LTE]:UL:SRS:CYCS` on page 108

SRS Rel Power
Defines the power of the SRS relative to the power of the corresponding UE (P_{SRS_Offset}).

The effective power level of the SRS is calculated as follows.

$P_{SRS} = P_{UE} + P_{SRS\_Offset}$

The relative power of the SRS is applied to all subframes.

Remote command:
`CONFigure[:LTE]:UL:SRS:POWer` on page 109

SRS BW Conf. C_SRS
Defines the bandwidth configuration of the SRS.

The bandwidth configuration is a cell specific parameter that, in combination with the SRS bandwidth and the channel bandwidth, defines the length of the souunding reference signal sequence. For more information on the calculation refer to 3GPP TS 36.211 chapter 5.5.3 "Sounding Reference Signal".

Remote command:
`CONFigure[:LTE]:UL:SRS:CSRS` on page 108

Conf. Index I_SRS
Defines the configuration index of the SRS.

The configuration index I_{SRS} is a cell specific parameter that determines the SRS periodicity (T_{SRS}) and the SRS subframe offset (T_{offset}). The effects of the configuration index on T_{SRS} and T_{offset} depends on the duplexing mode.

For more information refer to 3GPP TS 36.213, Table 8.2-1 (FDD) and 8.2-2 (TDD).

Remote command:
`CONFigure[:LTE]:UL:SRS:ISRS` on page 108

Transm. Comb. k_TC
Defines the transmission comb k_{TC}.

The transmission comb. is a UE specific parameter. For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:TRComb` on page 110

Freq. Domain Pos. n_RRC
Defines the parameter n_{RRC}.

n_{RRC} is a UE specific parameter and determines the starting physical resource block of the SRS transmission.

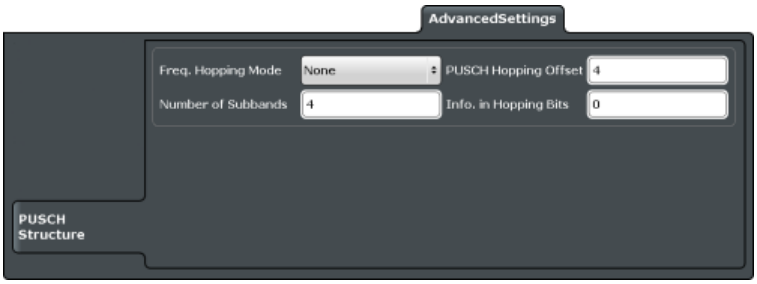
For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:NRRC` on page 109

Defining the PUSCH Structure

The PUSCH structure settings contain settings that describe the physical attributes and structure of the PUSCH.

The PUSCH structure settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Frequency Hopping Mode....45
Number of Subbands....45
PUSCH Hopping Offset....46
Info. in Hopping Bits....46

Frequency Hopping Mode
Selects the frequency hopping mode of the PUSCH.

Several hopping modes are supported.

- None
  No frequency hopping.
- Inter Subframe Hopping
  PUSCH changes the frequency from one subframe to another.
- Intra Subframe Hopping
  PUSCH also changes the frequency within a subframe.

Remote command:
`CONFigure[:LTE]:UL:PUSCh:FHMode` on page 110

Number of Subbands
Defines the number of subbands reserved for PUSCH.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:PUSCh:NOSM` on page 111

PUSCH Hopping Offset
Defines the PUSCH Hopping Offset N_{RB}^{HO}.

The PUSCH Hopping Offset determines the first physical resource block and the maximum number of physical resource blocks available for PUSCH transmission if PUSCH frequency hopping is active.

Remote command:
`CONFigure[:LTE]:UL:PUSCh:FHOFfset` on page 111

Info. in Hopping Bits
Defines the information available in the hopping bits according to the PDCCH DCI format 0 hopping bit definition.

The information in the hopping bits determines whether type 1 or type 2 hopping is used in the subframe and, in case of type 1, additionally determines the exact hopping function to use.

For more information on PUSCH frequency hopping refer to 3GPP TS36.213.

Remote command:
`CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB` on page 111

Defining the PUCCH Structure

The PUCCH structure settings contain settings that describe the physical attributes and structure of the PUCCH.

The PUCCH structure settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.

No. of RBs for PUCCH....46
N(1)_cs....47
Delta Shift....47
Format....47
N(2)_RB....47
N_PUCCH....48

No. of RBs for PUCCH
Defines the number of resource blocks reserved for PUCCH.

The resource blocks for PUCCH are always allocated at the edges of the LTE spectrum.

In case of an even number of PUCCH resource blocks, half of the available PUCCH resource blocks is allocated on the lower, the other half on the upper edge of the LTE spectrum (outermost resource blocks).

In case of an odd number of PUCCH resource blocks, the number of resource blocks on the lower edge is one resource block larger than the number of resource blocks on the upper edge of the LTE spectrum.

Remote command:
`CONFigure[:LTE]:UL:PUCCh:NORB` on page 113

N(1)_cs
Defines the number of cyclic shifts used for PUCCH format 1/1a/1b in a resource block used for a combination of the formats 1/1a/1b and 2/2a/2b.

Only one resource block per slot can support a combination of the PUCCH formats 1/1a/1b and 2/2a/2b.

The number of cyclic shifts available for PUCCH format 2/2a/2b N(2)_cs in a block with combination of PUCCH formats is calculated as follows.

N(2)_cs = 12 - N(1)_cs - 2

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:N1CS` on page 112

Delta Shift
Defines the delta shift parameter.

The delta shift is the difference between two adjacent PUCCH resource indices with the same orthogonal cover sequence (OC).

It determines the number of available sequences in a resource block that can be used for PUCCH formats 1/1a/1b.

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:DESHift` on page 111

Format
Selects the format of the PUCCH.

You can define the PUCCH format for all subframes or define the PUCCH format for each subframe individually.

- F1, F1a, F1b, F2, F2a, F2b, F3
  Selects the PUCCH format globally for every subframe.

Note that formats F2a and F2b are only supported for normal cyclic prefix length.

For more information refer to 3GPP TS36.211, table 5.4-1 "Supported PUCCH Formats".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:FORMat` on page 112

N(2)_RB
Defines bandwidth in terms of resource blocks that are reserved for PUCCH formats 2/2a/2b transmission in each subframe.

Since there can be only one resource block per slot that supports a combination of the PUCCH formats 1/1a/1b and 2/2a/2b, the number of resource block(s) per slot available for PUCCH format 1/1a/1b is determined by N(2)_RB.

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:N2RB` on page 112

N_PUCCH
Defines the resource index for PUCCH format 1/1a/1b respectively 2/2a/2b.

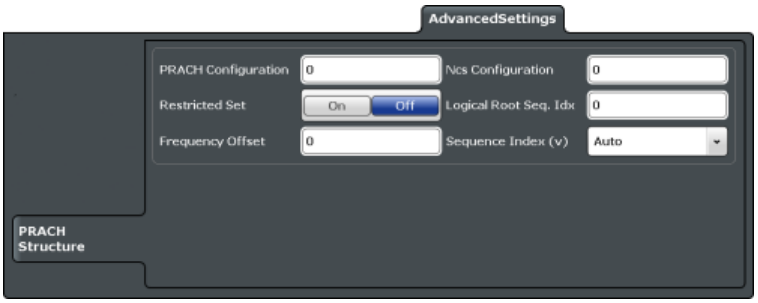
It is also possible to define N_{PUCCH} on a subframe level by selecting the "Per Subframe" menu item. For more information see chapter 4.2.1.2, "Configuring Subframes", on page 37.

Remote command:
`CONFigure[:LTE]:UL:PUCCh:NPAR` on page 113

Defining the PRACH Structure

The PRACH structure settings contain settings that describe the physical attributes and structure of the PUCCH.

The PRACH structure settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



PRACH Configuration....48
Restricted Set....49
Frequency Offset....49
PRACH Preamble Mapping....49
Ncs Conf....49
Logical Root Sequ. Idx....49
Sequence Index (v)....49

PRACH Configuration
Sets the PRACH configuration index as defined in the 3GPP TS 36.211, i.e. defines the subframes in which random access preamble transmission is allowed.

The preamble format is automatically derived form the PRACH Configuration.

Remote command:
`CONFigure[:LTE]:UL:PRACh:CONF` on page 114

Restricted Set
Selects whether a restricted preamble set (high speed mode) or the unrestricted preamble set (normal mode) will be used.

Remote command:
`CONFigure[:LTE]:UL:PRACh:RSET` on page 115

Frequency Offset
For preamble formats 0-3, sets the PRACH Frequency Offset as defined in the 3GPP TS 36.211, i.e. determines the first physical resource block available for PRACH expressed as a physical resource block number.

Remote command:
`CONFigure[:LTE]:UL:PRACh:FOFFset` on page 114

PRACH Preamble Mapping
The frequency resource index f_{RA} and the half frame indicator $t1_{RA}$ are neccessary to clearly specify the physical resource mapping of the PRACH in case a PRACH configuration index has more than one mapping alternative.

If you turn on the "Auto Preamble Mapping", the software automatically detects f_{RA} and $t1_{RA}$.

The values for both parameters are defined in table '5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency' (3GPP TS 36.211 v10.2.0).

The frequency resource index and half frame indicator are available in TDD mode.

Remote command:
`CONFigure[:LTE]:UL:PRACh:APM` on page 113
`CONFigure[:LTE]:UL:PRACh:FRINdex` on page 114
`CONFigure[:LTE]:UL:PRACh:HFINdicator` on page 114

Ncs Conf
Selects the Ncs configuration, i.e. determines the Ncs value set according to TS 36.211, table 5.7.2.-2 and 5.7.2-3.

Remote command:
`CONFigure[:LTE]:UL:PRACh:NCSC` on page 115

Logical Root Sequ. Idx
Selects the logical root sequence index.

The logical root sequence index is used to generate preamble sequences. It is provided by higher layers.

Remote command:
`CONFigure[:LTE]:UL:PRACh:RSEQ` on page 115

Sequence Index (v)
Defines the sequence index (v).

The sequence index controls which of the 64 preambles available in a cell is used.

If you select the "Auto" menu item, the software automatically selects the required sequence index.

Remote command:
`CONFigure[:LTE]:UL:PRACh:SINDex` on page 115

4.2.2 Input / Frontend

- Selecting the Input and Output Source....50
- Defining the Frequency....50
- Defining Level Characteristics....51

4.2.2.1 Selecting the Input and Output Source

The application supports several input sources and outputs. These are the same as in Spectrum mode.

For a comprehensive description of the supported input sources (including the Digital Baseband In- and Output), please refer to the documentation of the R&S FSW.

4.2.2.2 Defining the Frequency

Frequency settings define the frequency characteristics of the signal at the RF input.

Defining the Signal Frequency....50

Defining the Signal Frequency
For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

The frequency setting is available for the RF input source.

In addition to the frequency itself, you can also define a frequency stepsize. The frequency stepsize defines the extent of a frequency change if you change it for example with the rotary knob. Define the stepsize in two ways.

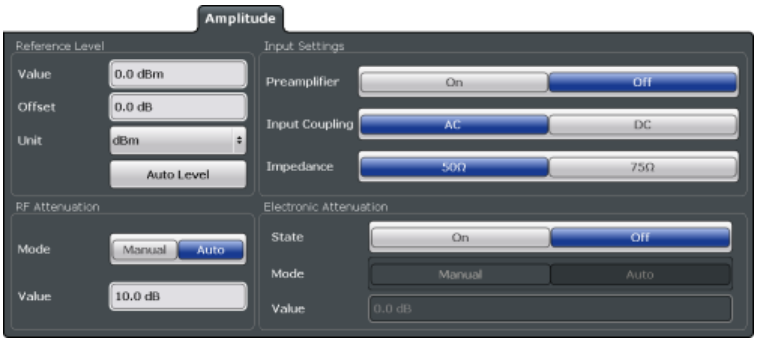
- = Center
  One frequency step corresponds to the current center frequency.
- Manual

Define a any stepsize you need.

Remote command:
Center frequency:
[SENSe]:FREQuency:CENTer on page 116
Frequency stepsize:
[SENSe:]FREQuency:CENTer:STEP on page 116
Frequency offset:
[SENSe:]FREQuency:OFFSet on page 117

4.2.2.3 Defining Level Characteristics

Amplitude settings define the expected level characteristics of the signal at the RF input.



Defining a Reference Level....51
Attenuating the Signal....52
Preamplifier (option B24)....53
Input Coupling....53
Impedance....53

Defining a Reference Level

The reference level is the power level the R&S FSW expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

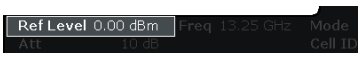
You can specify the reference level in several **units** and define an arithmetic **level offset**. A level offset is useful if the signal is attenuated or amplified before it is fed into the analyzer. All displayed power level results will be shifted by this value. Note however, that the reference value ignores the level offset. Thus, it is still mandatory to define the actual power level that the analyzer has to handle as the reference level.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value.

Automatic level detection also optimizes RF attenuation.

The application shows the current reference level (including RF and external attenuation) in the channel bar.



Remote command:
Manual:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel` on page 118
Automatic:
`[SENSe:]ADJust:LEVel` on page 122
Offset:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet` on page 118
Unit:
`CALCulate<n>:UNIT:POWer` on page 118

Attenuating the Signal
Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE application provides several attenuation modes.

- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
- If you have equipped your R&S FSW with option R&S FSW-B25, it also provides **electronic** attenuation. Note that the frequency range may not exceed the specification of the electronic attenuator for it to work.
  For both methods, the application provides **automatic** detection of the ideal attenuation level. Alternatively, you can define the attenuation level **manually**. The range is from 0 dB to 79 dB (RF attenuation) or 30 dB (electronic attenuation) in 1 dB steps.

For more information on attenuating the signal see the manual of the R&S FSW.

The application shows the attenuation level (mechanical and electronic) in the channel bar.

Remote command:
RF attenuation:
`INPut:ATTenuation` on page 118
`INPut:ATTenuation:AUTO` on page 119
Electronic attenuation:
`INPut<n>:EATT:STATe` on page 121
`INPut<n>:EATT:AUTO` on page 121
`INPut<n>:EATT` on page 121

Preamplifier (option B24)
If option R&S FSW-B24 is installed, a preamplifier can be activated for the RF input signal.

For R&S FSW 26 models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW 8 or 13 models, the following settings are available:

You can use a preamplifier to analyze signals from DUTs with low input power.

"Off" Deactivates the preamplifier.

"15 dB" The RF input signal is amplified by about 15 dB.

"30 dB" The RF input signal is amplified by about 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 120
`INPut:GAIN[:VALue]` on page 119

Input Coupling
The RF input of the R&S FSW can be coupled by alternating current (AC) or direct current (DC).

This function is not available for input from the Digital Baseband Interface (R&S FSW-B17) or from the Analog Baseband Interface (R&S FSW-B71).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 119

Impedance
The reference impedance for the measured levels of the R&S FSW can be set to 50 Ω or 75 Ω.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

This value also affects the unit conversion.

This function is not available for input from the Digital Baseband Interface (R&S FSW-B17) or from the Analog Baseband Interface (R&S FSW-B71). For analog baseband input, an impedance of 50 Ω is always used.

Remote command:
`INPut:IMPedance` on page 120

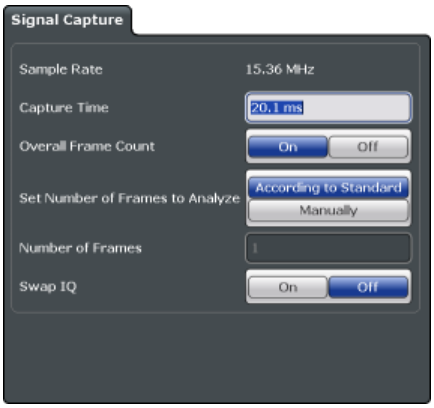
4.2.3 Signal Capture

- Configuring the Data Capture....54
- Triggering Measurements....55

4.2.3.1 Configuring the Data Capture

The data capture settings contain settings that control the data capture.

The data capture settings are part of the "Signal Capture" tab of the "Trigger/Signal Capture" dialog box.



Capture Time
Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

The application shows the current capture time in the channel bar.

Remote command:
`[SENSe]:SWEep:TIME` on page 123

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the R&S FSW analyzes all complete LTE frames currently in the capture buffer.

The application shows the current frame count in the channel bar.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:STATe on page 122

Auto According to Standard
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSW evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

This parameter is not available if the overall frame count is inactive.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:AUTO on page 123

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSW continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt on page 122

Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
[SENSe]:SWAPiq on page 123

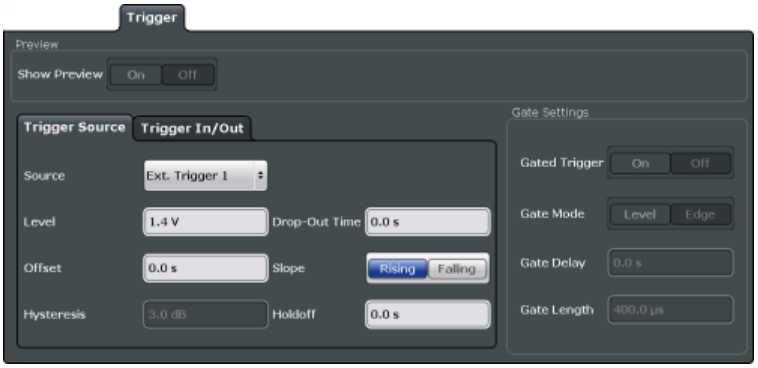
4.2.3.2 Triggering Measurements

The trigger functionality of the LTE measurement application is the same as that of the R&S FSW. For a comprehensive description of the available trigger settings see the documentation of the R&S FSW.

Note that some trigger sources available in Spectrum mode are not available in the LTE application. Note also that the Preview and Gate functionality are only available for frequency sweep measurements (ACLR and SEM).

Gated frequency sweep measurements
The application automatically selects the correct gate settings (delay and length) according to the TDD configuration.

The trigger settings are part of the "Trigger" tab of the "Trigger/Signal Capture" dialog box.



For more information on triggering measurements see the documentation of the R&S FSW.

4.2.4 Tracking

The tracking settings contain settings that compensate for various common measurement errors that may occur.

Phase....56
Timing....56

Phase
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

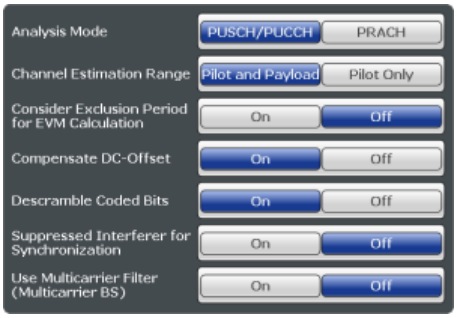
"Off"	Phase tracking is not applied.
"Pilot Only"	Only the reference signal is used for the estimation of the phase error.
"Pilot and Payload"	Both reference signal and payload resource elements are used for the estimation of the phase error.

Remote command:
`[SENSe][:LTE]:UL:TRACking:PHASe` on page 126

Timing
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

Remote command:
`[SENSe][:LTE]:UL:TRACking:TIME` on page 126

4.2.5 Signal Demodulation



Analysis Mode....57
Channel Estimation Range....57
EVM with Exclusion Period....57
Compensate DC Offset....58
Scrambling of Coded Bits....58
Suppressed Interference Synchronization....58
Multicarrier Filter....58

Analysis Mode
Selects the channel analysis mode.

You can select from "PUSCH/PUCCH" mode and "PRACH" mode.

PUSCH/PUCCH mode analyzes the PUSCH and PUCCH. This is the default.

PRACH mode analyzes the PRACH only. In PRACH analysis mode no subframe or slot selection is available. Instead you can select a particular preamble that the results are shown for. Note that PRACH analysis mode does not support all result displays.

Remote command:
`[SENSe][:LTE]:UL:DEMod:MODE` on page 124

Channel Estimation Range
Selects the method for channel estimation.

You can select if only the pilot symbols are used to perform channel estimation or if both pilot and payload carriers are used.

Remote command:
`[SENSe][:LTE]:UL:DEMod:CESTimation` on page 124

EVM with Exclusion Period
Turns exclusion periods for EVM measurements as defined in 3GPP TS 36.521 on and off.

The exclusion period affects the PUSCH data EVM of the first and last symbol.

The software automatically determines the length of the exclusion period according to 3GPP TS 36.521-1.

The exclusion period has no effect on the EVM vs Carrier and EVM vs Symbol x Carrier result displays.

Remote command:
`[SENSe][:LTE]:UL:DEMod:EEPeriod` on page 124

Compensate DC Offset
Turns DC offset compensation when calculating measurement results on and off.

According to 3GPP TS 36.101 (Annex F.4), the R&S FSW removes the carrier leakage (I/Q origin offset) from the evaluated signal before it calculates the EVM and in-band emissions.

Remote command:
`[SENSe][:LTE]:UL:DEMod:CDCoffset` on page 125

Scrambling of Coded Bits
Turns the scrambling of coded bits for the PUSCH on and off.

The scrambling of coded bits affects the bitstream results.

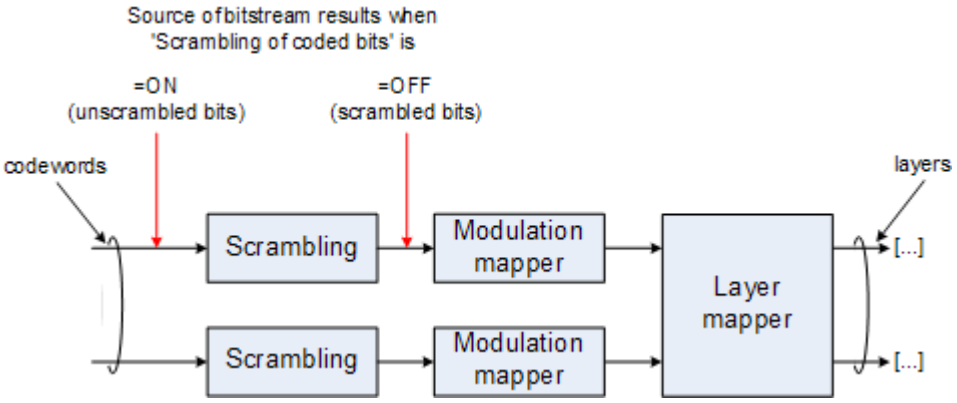


Fig. 4-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
`[SENSe][:LTE]:UL:DEMod:CBSCrambling` on page 125

Suppressed Interference Synchronization
Turns suppressed interference synchronization on and off.

If active, the synchronization on signals containing more than one user equipment (UE) is more robust. Additionally, the EVM is lower in case the UEs have different frequency offsets. Note that Auto Demodulation is not supported in this synchronization mode and the EVM may be higher in case only one UE is present in the signal.

Remote command:
`[SENSe][:LTE]:UL:DEMod:SISYnc` on page 125

Multicarrier Filter
Turns the suppression of interference of neighboring carriers on and off.

Remote command:
`[SENSe][:LTE]:UL:DEMod:MCFilter` on page 125

4.3 Configuring Frequency Sweep Measurements

After starting one of the frequency sweep measurements, the application automatically loads the configuration required by measurements according to the 3GPP standard: the spectral mask as defined in the 3GPP standard for SEM measurements and the channel configuration defined in the standard for the ACLR measurement.

If you need a different measurement configuration, you can change all parameters as required. Except for the dialog box decribed below, the measurement configuration menus for the frequency sweep measurements are the same as in the Spectrum application.

Please refer to the User Manual of the R&S FSW for a detailed description on how to configure ACLR and SEM measurements.

4.3.1 ACLR Signal Description

The signal description for ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model and Channel Bandwidth see "Selecting the LTE Mode" on page 33, "Using Test Models" on page 33 and "Channel Bandwidth / Number of Resource Blocks" on page 34.

Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

Remote command:
`[SENSe]:POWer:ACHannel:AACHannel` on page 127

4.3.2 SEM Signal Description

The signal description for SEM measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model, Channel Bandwidth and Cyclic Prefix see "Selecting the LTE Mode" on page 33, "Using Test Models" on page 33, "Channel Bandwidth / Number of Resource Blocks" on page 34 and "Cyclic Prefix" on page 35.

SEM Requirement
Selects the type of spectrum emission mask used for the Out of Band emission measurement.

The software supports general and specific (additional) spectrum emission masks. The specific spectrum emission masks contain additional SEM requirements. The additional requirements masks to use for the measurement depend on the network signalled value "NS_03", "NS_04", "NS_06" or "NS_07".

If "NS_06" or "NS_07" is indicated in the cell, use SEM requirement "NS_06_07".

Remote command:
`[SENSe]:POWer:SEM:UL:REQuirement` on page 127

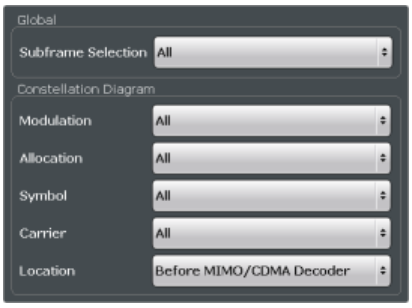
5 Analysis

5.1 Analyzing I/Q Measurements

- Evaluation Range....61
- Scale....63
- Result Settings....63
- Markers....64

5.1.1 Evaluation Range

The evaluation range defines the signal parts that are considered during signal analysis.



Subframe Selection....61
Slot Selection....62
Preamble Selection....62
Evaluation Range for the Constellation Diagram....62

Subframe Selection
Selects a particular subframe whose results the software displays.

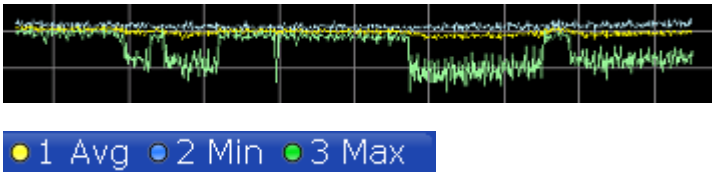
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Inband Emission, Channel Flatness, Channel Flatness SRS, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, DFT Precoded Constellation, Allocation Summary and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

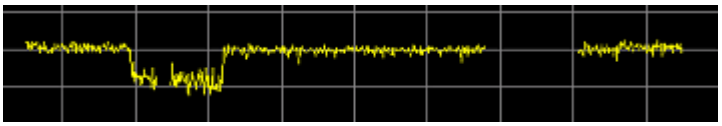
Example: Subframe selection

If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



Remote command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 129

Slot Selection
Selects a particular slot whose measurement results you want to see.

You can select a particular slot for the following measurements.

Result Summary, EVM vs Carrier, EVM vs Symbol, Inband Emission, Channel Flatness, Channel Flatness SRS, Channel Group Delay, Channel Flatness Difference, Constellation diagram and DFT Precoded Constellation diagram.

In PRACH analysis mode, you can not select a particular slot.

Remote command:
`[SENSe][:LTE]:SLOT:SELect` on page 128

Preamble Selection
Selects a particular preamble for measurements that analyze individual preambles.

Selecting preambles is available in PRACH analysis mode.

Remote command:
`[SENSe][:LTE]:PREamble:SELect` on page 128

Evaluation Range for the Constellation Diagram
The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the Constellation Diagram.

By default the R&S FSW displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.

- Modulation
  Filters the results to include only the selected type of modulation.

- Allocation
  Filters the results to include only a particular type of allocation.
- Symbol
  Filters the results to include only a particular OFDM symbol.
- Carrier
  Filters the results to include only a particular subcarrier.

The result display is updated as soon as you make the changes.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

5.1.2 Scale

Y-Axis Scale....63

Y-Axis Scale
The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you are using the **automatic scale** function.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis by defining the **minimum** and **maximum** values displayed on the vertical axis. Possible values and units depend on the result display you want to adjust the scale of.

Tip:

Alternatively, you can scale the windows in the "Auto Set" menu. In addition to scaling the window currently in focus ("Auto Scale Window"), there you can scale **all windows** at the same time ("Auto Scale All").

Remote command:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE` on page 129
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum` on page 129
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum` on page 129

5.1.3 Result Settings

Result settings define the way certain measurement results are displayed.

EVM Unit....64
Bit Stream Format....64

EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
UNIT:EVM on page 130

Bit Stream Format
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

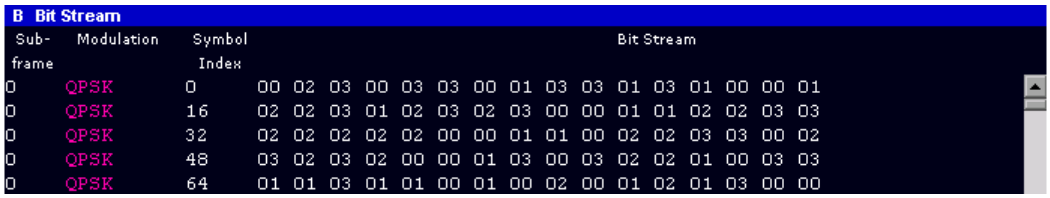


Fig. 5-1: Bit stream display in uplink application if the bit stream format is set to "symbols"

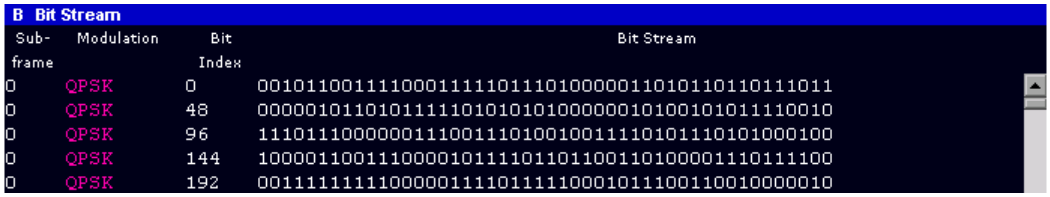


Fig. 5-2: Bit stream display in uplink application if the bit stream format is set to "bits"

Remote command:
UNIT:BSTR on page 130

5.1.4 Markers

Markers are available for most of the I/Q measurement result displays and for the frequency sweep measurements. The functionality (setting and positioning) is the same as in Spectrum mode.

For a comprehensive description of the marker functionality see the corresponding chapters in the documentation of the R&S FSW.

5.2 Analyzing Frequency Sweep Measurements

The LTE application supports the same functionality to analyze the results of frequency sweep measurements (Spectrum Emission mask and Adjacent Channel Leakage Ratio) as the R&S FSW base unit does for those measurements.

Please refer to the User Manual of the R&S FSW for a detailed description on how to analyze ACLR and SEM measurements.

6 Remote Control

6.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.
<m>	Selects a marker. Irrelevant for the LTE application.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

6.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSW.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

6.2.1 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

6.2.2 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

6.2.3 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

6.2.4 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

6.2.5 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

- Numeric Values....68
- Boolean....69
- Character Data....70
- Character Strings....70
- Block Data....70

6.2.5.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

6.2.5.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

6.2.5.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 6.2.1, "Long and Short Form", on page 67.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

6.2.5.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

6.2.5.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

6.3 Remote Commands to Select the LTE Application

INSTrument:CREate:DUPLicate....71
INSTrument:CREate[:NEW]....71
INSTrument:CREate:REPLace....71
INSTrument:DELete....72
INSTrument:LIST?....72
INSTrument:REName....73
INSTrument[:SELect]....73

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e starts a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "Spectrum" -> "Spectrum 2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

This command is not available if the MSRA Master channel is selected.

Example:
```
INST:SEL 'Spectrum'
INST:CRE:DUPL
```
Duplicates the channel named 'Spectrum' and creates a new measurement channel named 'Spectrum 2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel. The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 6-1.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 6-1).

Example:
```
INST:CRE SAN, 'Spectrum 2'
```
Adds an additional spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 6-1.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 6-1).

Example: `INST:CRE:REPL 'Spectrum2',IQ,'IQAnalyzer'`
Replaces the channel named 'Spectrum2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

INSTrument:DELete <ChannelName>

This command deletes a measurement channel. If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'Spectrum4'`
Deletes the spectrum channel with the name 'Spectrum4'.

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see table 6-1).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 3 measurement channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','SANALYZER','Spectrum'`

Usage: Query only

Table 6-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> Parameter	Default Channel Name*)
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
VSA (R&S FSW-K70)	DDEM	VSA
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'Spectrum2','Spectrum3'`
Renames the channel with the name 'Spectrum2' to 'Spectrum3'.

INSTrument[:SELect] <ChannelType>

This command selects a new measurement channel with the defined channel type.

Parameters:

<ChannelType> **LTE**
LTE measurement channel (R&S FSW-K10x)

Example: `INST LTE`
Selects the LTE application.

6.4 Performing Measurements

6.4.1 Measurements

ABORt....74
INITiate:CONTinuous....75
INITiate[:IMMediate]....75
[SENSe]:SYNC[:STATe]?....76

ABORt

This command aborts a current measurement and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSW User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate:SEQuencer:ABORt` on page 76 command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel (GPIB, LAN or other interface) to the R&S FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: SCPI confirmed

INITiate:CONTinuous <State>

This command controls the sweep mode.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 76) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Parameters:

<State> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: ON

Example: `INIT:CONT OFF`
Switches the sweep mode to single sweep.
`INIT:CONT ON`
Switches the sweep mode to continuous sweep.

INITiate[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Example: (For Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Sets the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:
<State> The string contains the following information.
A zero represents a failure and a one represents a successful synchronization.

Example: `SYNC:STAT?`
Would return, e.g. '1' for successful synchronization.

Usage: Query only

6.4.2 Measurement Sequences

INITiate:SEQuencer:ABORt....76
INITiate:SEQuencer:IMMediate....76
INITiate:SEQuencer:MODE....77
SYSTem:SEQuencer....78

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate:SEQuencer:IMMediate` on page 76.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 78.

Usage: Event

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer. Its effect is similar to the `INITiate[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 78).

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate:SEQuencer:MODE <Mode>

This command selects the way the R&S FSW application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 78).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequencer mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single Sequencer mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.
```
SYST:SEQ OFF
```

6.5 Remote Commands to Read Trace Data

- Using the TRACe[:DATA] Command....78
- Remote Commands to Read Measurement Results....87

6.5.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

```
TRAC:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe<n>[:DATA]?`).

- Adjacent Channel Leakage Ratio....79
- Allocation Summary....79
- Bit Stream....80
- Capture Buffer....81
- CCDF....81
- Channel Flatness....81
- Channel Flatness Difference....82
- Channel Flatness SRS....82
- Channel Group Delay....83
- Constellation Diagram....83
- EVM vs Carrier....84
- EVM vs Symbol....84
- EVM vs Subframe....84
- Frequency Error vs Symbol....84
- Inband Emission....85
- Power Spectrum....85
- Spectrum Emission Mask....85
- Return Value Codes....86

6.5.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
- LIST
  Returns the contents of the ACLR table.

6.5.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

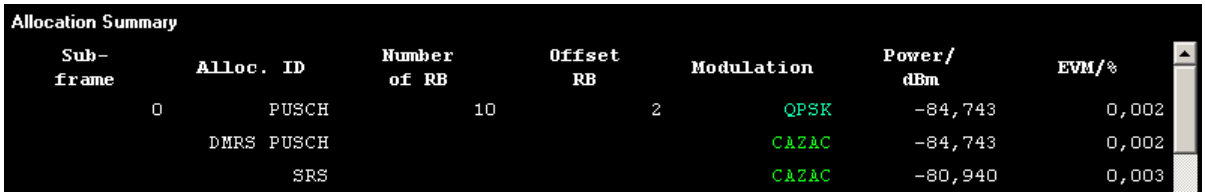
```
<subframe>, <allocation ID>, <number of RB>, <offset RB>,
<modulation>, <absolute power>, <EVM>, ...
```

The unit for <absolute power> is always dBm. The unit for <EVM> depends on UNIT:EVM. All other values have no unit.

The <allocation ID> and <modulation> are encoded. For the code assignment see chapter 6.5.1.18, "Return Value Codes", on page 86.

Note that the data format of the return values is always ASCII.

Example:



TRAC:DATA? TRACE1 would return:

```
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
0, -42, 0, 0, 6, -80.9404231343884, 3.97834623871343E-06,
...
```

6.5.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

<subframe>, <modulation>, <# of symbols/bits>,
<hexadecimal/binary numbers>,...

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The <modulation> is encoded. For the code assignment see chapter 6.5.1.18, "Return Value Codes", on page 86.

For symbols or bits that are not transmitted, the command returns

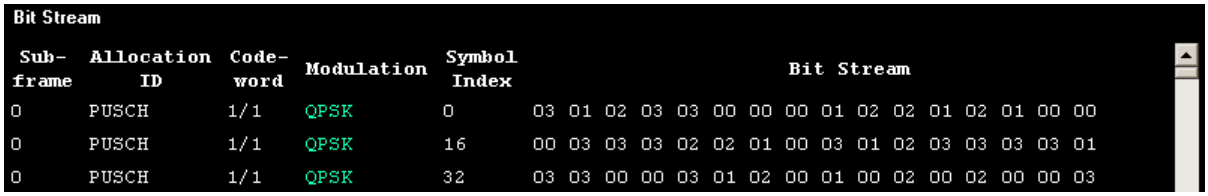
- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:



Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PUSCH	1/1	QPSK	0	03 01 02 03 03 00 00 00 01 02 02 01 02 01 00 00
0	PUSCH	1/1	QPSK	16	00 03 03 03 02 02 01 00 03 01 02 03 03 03 03 01
0	PUSCH	1/1	QPSK	32	03 03 00 00 03 01 02 00 01 00 02 00 02 00 00 03

`TRAC:DATA? TRACE1` would return:

```
0, -40, 0, 2, 0, 03, 01, 02, 03, 03, 00, 00, 00, 01, 02, 02, ...
<continues like this until the next data block starts or the end of data is reached>
0, -40, 0, 2, 32, 03, 03, 00, 00, 03, 01, 02, 00, 01, 00, ...
```

6.5.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

```
<absolute power>, ...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1

6.5.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  `<# of values>, <relative power>, ...`
  The unit is always dB.
  The first value that is returned is the number of the following values.

6.5.1.6 Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.5.1.7 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.5.1.8 Channel Flatness SRS

For the Channel Flatness SRS result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.5.1.9 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

```
<group delay>, ...
```

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average group delay over all subframes.
- TRACE2
  Returns the minimum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.5.1.10 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Symb0][Carrier1]>, <Q[SF0][Symb0][Carrier1]>, ..., <I[SF0][Symb0][Carrier(n)]>, <Q[SF0][Symb0][Carrier(n)]>,

<I[SF0][Symb1][Carrier1]>, <Q[SF0][Symb1][Carrier1]>, ..., <I[SF0][Symb1][Carrier(n)]>, <Q[SF0][Symb1][Carrier(n)]>,

<I[SF0][Symb(n)][Carrier1]>, <Q[SF0][Symb(n)][Carrier1]>, ..., <I[SF0][Symb(n)][Carrier(n)]>, <Q[SF0][Symb(n)][Carrier(n)]>,

<I[SF1][Symb0][Carrier1]>, <Q[SF1][Symb0][Carrier1]>, ..., <I[SF1][Symb0][Carrier(n)]>, <Q[SF1][Symb0][Carrier(n)]>,

<I[SF1][Symb1][Carrier1]>, <Q[SF1][Symb1][Carrier1]>, ..., <I[SF1][Symb1][Carrier(n)]>, <Q[SF1][Symb1][Carrier(n)]>,

<I[SF(n)][Symb(n)][Carrier1]>, <Q[SF(n)][Symb(n)][Carrier1]>, ..., <I[SF(n)][Symb(n)][Carrier(n)]>, <Q[SF(n)][Symb(n)][Carrier(n)]>

With SF = subframe and Symb = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.
- TRACE2
  Returns the constellation points of the reference symbols included in the selection.
- TRACE3
  Returns the constellation points of the SRS included in the selection.

6.5.1.11 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.5.1.12 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<EVM>, ...
```

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.5.1.13 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

```
<EVM>, ...
```

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.5.1.14 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<frequency error>,...
```

The unit is always Hz.

The following parameters are supported.

- TRACE1

6.5.1.15 Inband Emission

For the Inband Emission result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns the relative resource block indices (x-axis values).
  `<RB index>, ...`
  The resource block index has no unit.
- TRACE2
  Returns one value for each resource block index.
  `<relative power>, ...`
  The unit of the relative inband emission is dB.
- TRACE3
  Returns the data points of the upper limit line.
  `<limit>, ...`
  The unit is always dB.

Note that you have to select a particular subframe to get results.

6.5.1.16 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

6.5.1.17 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns nine values.

`<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, ...`
The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

6.5.1.18 Return Value Codes

This chapter contains a list for encoded return values.

<allocation ID>

Represents the allocation ID. The value is a number in the range {1...-70}.

- **1** = Reference symbol
- **0** = Data symbol
- **-1** = Invalid
- **-40** = PUSCH
- **-41** = DMRS PUSCH
- **-42** = SRS PUSCH
- **-50** = PUCCH
- **-51** = DMRS PUCCH
- **-70** = PRACH

<codeword>

Represents the codeword of an allocation. The range is {0...2}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2

<modulation>

Represents the modulation scheme. The range is {0...8}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

TRACe<n>[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 6.5.1, "Using the TRACe[:DATA] Command", on page 78.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

Usage: Query only

6.5.2 Remote Commands to Read Measurement Results

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?....87
CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?....88
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?....88
FORMat[:DATA]....89

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result> **ALL**
Queries the overall limit check results.

REL
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower adjacent channel.

1
Limit check has passed.

0
Limit check has failed.

Example: `CALC:LIM:ACP:ACH:RES? ALL`
Queries the results of the adjacent channel limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>

ALL
Queries the overall limit check results.

REL
Queries the channel power limit check results.

ABS
Queries the distance to the limit line.

Return values:

<LimitCheck>

Returns two values, one for the upper and one for the lower alternate channel.

1
Limit check has passed.

0
Limit check has failed.

Example:

```
CALC:LIM:ACP:ALT:RES? ALL
```

Queries the results of the alternate channel limit check.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m> 1

Query parameters:

CPOW

This parameter queries the signal power of the SEM measurement.

Return values:

<Result>

SEMResults
Power level in dBm.

ACLRResults
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES?`
Returns the current ACLR measurement results.

Usage: Query only

Manual operation: See "ACLR" on page 21

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: `FORM REAL`
The software will send binary data in Real32 data format.

6.6 Remote Commands to Read Numeric Results

- Frame Results....90
- Result for Selection....92
- Marker Table....96

6.6.1 Frame Results

FETCh:SUMMary:EVM:SDQP[:AVERage]?....90
FETCh:SUMMary:EVM:SDST[:AVERage]?....90
FETCh:SUMMary:EVM:UCCD[:AVERage]?....90
FETCh:SUMMary:EVM:UCCH[:AVERage]?....91
FETCh:SUMMary:EVM:UPRA[:AVERage]?....91
FETCh:SUMMary:EVM:USQP[:AVERage]?....91
FETCh:SUMMary:EVM:USST[:AVERage]?....92

FETCh:SUMMary:EVM:SDQP[:AVERage]?

This command queries the EVM of all DMRS resource elements with QPSK modulation of the PUSCH.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:SDQP?`
Returns the EVM of all DMRS resource elements with QPSK modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:SDST[:AVERage]?

This command queries the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:SDST?`
Returns the EVM of all DMRS resource elements with 16QAM modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:UCCD[:AVERage]?

This command queries the EVM of all DMRS resource elements of the PUCCH as shown in the result summary.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:UCCD?`
Returns the average EVM of all DMRS resource elements.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:UCCH[:AVERage]?

This command queries the EVM of all resource elements of the PUCCH as shown in the result summary.

Return values:
<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:UCCH?`
Returns the average EVM of all resource elements.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:UPRA[:AVERage]?

This command queries the EVM of all resource elements of the PRACH as shown in the result summary.

Return values:
<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:UPRA?`
Returns the average EVM of all resource elements.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:USQP[:AVERage]?

This query returns the EVM for all QPSK-modulated resource elements of the PUSCH.

Return values:
<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:USQP?`
Queries the PUSCH QPSK EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:USST[:AVERage]?

This query returns the the EVM for all 16QAM-modulated resource elements of the PUSCH.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:USST?`
Queries the PUSCH 16QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 18

6.6.2 Result for Selection

FETCh:SUMMary:CRESt[:AVERage]?....92
FETCh:SUMMary:EVM[:ALL]:MAXimum?....93
FETCh:SUMMary:EVM[:ALL]:MINimum?....93
FETCh:SUMMary:EVM[:ALL][:AVERage]?....93
FETCh:SUMMary:EVM:PCHannel:MAXimum?....93
FETCh:SUMMary:EVM:PCHannel:MINimum?....93
FETCh:SUMMary:EVM:PCHannel[:AVERage]?....93
FETCh:SUMMary:EVM:PSIGnal:MAXimum?....93
FETCh:SUMMary:EVM:PSIGnal:MINimum?....93
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?....93
FETCh:SUMMary:FERRor:MAXimum?....94
FETCh:SUMMary:FERRor:MINimum?....94
FETCh:SUMMary:FERRor[:AVERage]?....94
FETCh:SUMMary:GIMBalance:MAXimum?....94
FETCh:SUMMary:GIMBalance:MINimum?....94
FETCh:SUMMary:GIMBalance[:AVERage]?....94
FETCh:SUMMary:IQOFfset:MAXimum?....95
FETCh:SUMMary:IQOFfset:MINimum?....95
FETCh:SUMMary:IQOFfset[:AVERage]?....95
FETCh:SUMMary:POWer:MAXimum?....95
FETCh:SUMMary:POWer:MINimum?....95
FETCh:SUMMary:POWer[:AVERage]?....95
FETCh:SUMMary:QUADerror:MAXimum?....95
FETCh:SUMMary:QUADerror:MINimum?....95
FETCh:SUMMary:QUADerror[:AVERage]?....95
FETCh:SUMMary:SERRor:MAXimum?....96
FETCh:SUMMary:SERRor:MINimum?....96
FETCh:SUMMary:SERRor[:AVERage]?....96
FETCh:SUMMary:TFRame?....96

FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor> <numeric value>
Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM> <numeric value>
Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PCH?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:POW?`
Returns the total power in dBm

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: `FETC:SUMM:QUAD?`
Returns the current mean quadrature error in degrees.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`
Returns the current mean sampling error in ppm.

Usage: Query only

Manual operation: See "Result Summary" on page 18

FETCh:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the Capture Buffer result display.

Return values:

<Offset> Time difference between the (sub)frame start and capture buffer start.

Default unit: s

Example: `FETC:SUMM:TFR?`
Returns the (sub)frame start offset.

Usage: Query only

Manual operation: See "Capture Buffer" on page 9

6.6.3 Marker Table

CALCulate<n>:DELTamarker<m>:X....96
CALCulate<n>:DELTamarker<m>:Y?....97
CALCulate<n>:MARKer<m>:X....97
CALCulate<n>:MARKer<m>:Y?....97

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Example: `CALC:DELT:X?`
Outputs the (absolute) x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 75.

The unit depends on the application of the command.

Return values:
<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 21

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 75.

Return values:

<Result> Result at the marker position.

Example:

```
INIT:CONT OFF
```
Switches to single measurement mode.
```
CALC:MARK2 ON
```
Switches marker 2.
```
INIT;*WAI
```
Starts a measurement and waits for the end.
```
CALC:MARK2:Y?
```
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 21

6.7 Remote Commands to Configure the Application

6.7.1 General Configuration

The following remote control command control general configration of the application.

The remote control commands to select the result displays for I/Q measurements are described in chapter 6.10, "Working with Windows in the Display", on page 131.

CONFigure[:LTE]:MEASurement....98
SYSTem:PRESet:CHANnel[:EXECute]....99

CONFigure[:LTE]:MEASurement <Measurement>

This command selects the measurement.

Parameters:

<Measurement>

ACLR
Selects the Adjacent Channel Leakage Ratio measurement.

ESPectrum
Selects the Spectrum Emission Mask measurement.

EVM
Selects I/Q measurements with the "EVM" display configuration.

Example:

```
CONF:MEAS ACLR
```
Selects the ACLR measurement.

Manual operation: See "ACLR" on page 21
See "Spectrum Mask" on page 22

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 31

6.7.2 Configuring I/Q Measurements

- Signal Description....99
- Input / Frontend....116
- Signal Capture....122
- Demodulation....124
- Tracking....126

6.7.2.1 Signal Description

- Signal Characteristics....99
- Subframe Configuration....103
- Global Settings....105
- Demodulation Reference Signal....105
- Sounding Reference Signal....107
- PUSCH Structure....110
- PUCCH Structure....111
- PRACH Structure....113

Signal Characteristics

CONFigure[:LTE]:DUPLexing....99
CONFigure[:LTE]:LDIRection....100
CONFigure[:LTE]:UL:BW....100
CONFigure[:LTE]:UL:CYCPrefix....100
CONFigure[:LTE]:UL:PLC:CID....101
CONFigure[:LTE]:UL:PLC:CIDGroup....101
CONFigure[:LTE]:UL:PLC:PLID....101
CONFigure[:LTE]:UL:TDD:SPSC....102
CONFigure[:LTE]:UL:TDD:UDConf....102
[SENSe][:LTE]:SFLatness:ECONditions....102
[SENSe][:LTE]:SFLatness:OBANd....102

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example: `CONF:DUPL TDD`
Activates time division duplex.

Manual operation: See "Selecting the LTE Mode" on page 33

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

Manual operation: See "Selecting the LTE Mode" on page 33

CONFigure[:LTE]:UL:BW <Bandwidth>

This command selects the uplink bandwidth.

Parameters:

<Bandwidth>

BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

Example: `CONF:UL:BW BW1_40`
Sets a signal bandwidth of 1.4 MHz in uplink.

Manual operation: See "Channel Bandwidth / Number of Resource Blocks" on page 34

CONFigure[:LTE]:UL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for uplink signals.

Parameters:

<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: `CONF:UL:CYCP EXT`
Sets cyclic prefix type to extended.

Manual operation: See "Cyclic Prefix" on page 35

CONFigure[:LTE]:UL:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId>

AUTO
Automatically defines the cell ID.

<numeric value>
Number of the cell ID.

Range: 0 to 503

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 36

CONFigure[:LTE]:UL:PLC:CIDGroup <GroupNumber>

This command selects the cell identity group for uplink signals.

Parameters:

<GroupNumber>

Range: 1 to 167
*RST: 0

Example: `CONF:UL:PLCI:CIDG 12`
Selects cell identity group 12.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 36

CONFigure[:LTE]:UL:PLC:PLID <Identity>

This command selects the physical layer identity for uplink signals.

Parameters:

<Identity>

AUTO
Automatic selection

0...2
Manual selection

*RST: AUTO

Example: `CONF:DL:PLC:PLID 2`
Sets the physical layer identity to 2.
`CONF:DL:PLC:PLID AUTO`
Physical layer ID is selected automatically.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 36

CONFigure[:LTE]:UL:TDD:SPSC <Configuration>

This command selects the special subframe configuration for LTE uplink signals.

Parameters:
<Configuration> <numeric value>

Example: `CONF:UL:TDD:SPSC 2`
Selects special subframe configuration 2.

Manual operation: See "Configuring TDD Frames" on page 35

CONFigure[:LTE]:UL:TDD:UDConf <Configuration>

This command selects the UL/DL TDD subframe configuration for uplink signals.

Parameters:
<Configuration> Range: 0 to 6
*RST: 0

Example: `CONF:UL:TDD:UDC 4`
Selects allocation configuration number 4.

Manual operation: See "Configuring TDD Frames" on page 35

[SENSe][:LTE]:SFLatness:ECONditions <State>

This command turns extreme conditions for spectrum flatness measurements on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SFL:ECON ON`
Turns extreme conditions on.

Manual operation: See "Extreme Conditions" on page 37

[SENSe][:LTE]:SFLatness:OBANd <NofSubbands>

This command selects the operating band for spectrum flatness Measurements.

Parameters:
<NofSubbands> <numeric value>
Range: 1 to 40
*RST: 1

Example: `SFL:OBAN 10`
Selects operating band 10.

Manual operation: See "Operating Band Index" on page 37

Subframe Configuration

CONFigure[:LTE]:UL:CSUBframes....103
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT....103
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation....103
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount....104
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset....104
[SENSe][:LTE]:UL:DEMod:ACON....104
[SENSe][:LTE]:UL:FORMat:SCD....105

CONFigure[:LTE]:UL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the uplink signal.

Parameters:
<NofSubframes> Range: 0 to 9
*RST: 1

Example: `CONF:UL:CSUB 5`
Sets the number of configurable subframes to 5.

Manual operation: See "Subframe Configuration Table" on page 38

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT <Content>

This command allocates a PUCCH or PUSCH to an uplink allocation.

Parameters:
<Content>

NONE
Turns off the PUSCH and the PUCCH.

PUCCh
Turns on the PUCCH.

PUSCh
Turns on the PUSCH.

PSCC
Turns on the PUCCH as well as the PUSCH.

*RST: PUSC

Example: `CONF:UL:SUBF8:ALL:CONT PUCC`
Subframe 8 contains a PUCCH.

Manual operation: See "Subframe Configuration Table" on page 38

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation <Modulation>

This command selects the modulation of an uplink allocation.

Parameters:

<Modulation> QPSK | QAM16 | QAM64

*RST: QPSK

Example: `CONF:UL:SUBF8:ALL:MOD QPSK`
The modulation of the allocation in subframe 8 is QPSK.

Manual operation: See "Subframe Configuration Table" on page 38

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount <NofRBs>

This command selects the number of resource blocks in an uplink subframe.

Parameters:

<NofRBs> <numeric value>

*RST: 11

Example: `CONF:UL:SUBF8:ALL:RBC 8`
Subframe 8 consists of 8 resource blocks.

Manual operation: See "Subframe Configuration Table" on page 38

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset <RBOffset>

This command defines the resource block offset in an uplink subframe.

Parameters:

<RBOffset> <numeric value>

*RST: 2

Example: `CONF:UL:SUBF8:ALL:RBOF 5`
Subframe 8 has a resource block offset of 5.

Manual operation: See "Subframe Configuration Table" on page 38

[SENSe][:LTE]:UL:DEMod:ACON <Type>

This command selects the method of automatic demodulation for uplink signals.

Parameters:

<Type> **ALL**
Automatically detects and demodulates the PUSCH and SRS.

OFF
Automatic demodulation is off.

SCON
Automatically detects and demodulates the values available in the subframe configuration table.

Example: `UL:DEM:ACON OFF`
Turns automatic demodulation off.

Manual operation: See "Auto Demodulation" on page 38

[SENSe][:LTE]:UL:FORMat:SCD <State>

This command turns detection of the subframe configuration on and off.

The command is available if "Auto Demodulation" is turned off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `UL:FORM:SCD ON`
Turns detection of the subframe configuration on.

Manual operation: See "Subframe Configuration Detection" on page 39

Global Settings

CONFigure[:LTE]:UL:SFNO....105
CONFigure[:LTE]:UL:UEID....105

CONFigure[:LTE]:UL:SFNO <Offset>

This command defines the system frame number offset.

The application uses the offset to demodulate the frame.

Parameters:

<Offset> <numeric value>

*RST: 0

Example: `CONF:UL:SFNO 2`
Selects frame number offset 2.

Manual operation: See "Subframe Configuration Table" on page 38
See "Frame Number Offset" on page 40

CONFigure[:LTE]:UL:UEID <ID>

Sets the radio network temporary identifier (RNTI) of the UE.

Parameters:

<ID> <numeric value>

*RST: 0

Example: `CONF:UL:UEID 2`
Sets the UE ID to 2.

Manual operation: See "UE ID/n_RNTI" on page 40

Demodulation Reference Signal

CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer....106
CONFigure[:LTE]:UL:DRS:GRPHopping....106
CONFigure[:LTE]:UL:DRS:SEQHopping....106

CONFigure[:LTE]:UL:DRS:PUCCh:POWer....106
CONFigure[:LTE]:UL:DRS:NDMRs....107
CONFigure[:LTE]:UL:DRS:DSSHift....107

CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer <Power>

This command sets the relative power of the PUSCH.

Parameters:
<Power> *RST: 0
Default unit: DB

Example: `CONF:UL:DRS:POW 2`
Sets the relative power of the PUSCH to 2 dB.

Manual operation: See " Relative Power PUSCH" on page 41

CONFigure[:LTE]:UL:DRS:GRPHopping <State>

This command turns group hopping for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CONF:UL:DRS:GRPHopping ON`
Activates group hopping.

Manual operation: See " Group Hopping" on page 41

CONFigure[:LTE]:UL:DRS:SEQHopping <State>

This command turns sequence hopping for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CONF:UL:DRS:SEQH ON`
Activates sequence hopping.

Manual operation: See " Sequence Hopping" on page 41

CONFigure[:LTE]:UL:DRS:PUCCh:POWer <Power>

This command sets the relative power of the PUCCH.

Parameters:
<Power> *RST: 0
Default unit: DB

Example: `CONF:UL:DRS:PUCC:POW 2`
Sets the power of the PUCCH to 2 dB.

Manual operation: See " Relative Power PUCCH" on page 41

CONFigure[:LTE]:UL:DRS:NDMRs <nDMRS>

This command defines the n_{DMRS}.

Parameters:
<nDMRS> <numeric value>

Example: `CONF:UL:DRS:NDMR 0`
Selects n_{DMRS} 0.

Manual operation: See " n(1)_DMRS" on page 42

CONFigure[:LTE]:UL:DRS:DSSHift <Shift>

This command selects the delta sequence shift of the uplink signal.

Parameters:
<Shift> <numeric value>
*RST: 0

Example: `CONF:UL:DRS:DSSH 3`
Sets the delta sequence shift to 3.

Manual operation: See " Delta Sequence Shift" on page 42

Sounding Reference Signal

CONFigure[:LTE]:UL:SRS:BHOP....107
CONFigure[:LTE]:UL:SRS:BSRS....108
CONFigure[:LTE]:UL:SRS:CSRS....108
CONFigure[:LTE]:UL:SRS:CYCS....108
CONFigure[:LTE]:UL:SRS:ISRS....108
CONFigure[:LTE]:UL:SRS:MUPT....109
CONFigure[:LTE]:UL:SRS:NRRC....109
CONFigure[:LTE]:UL:SRS:POWer....109
CONFigure[:LTE]:UL:SRS:STAT....109
CONFigure[:LTE]:UL:SRS:SUConfig....110
CONFigure[:LTE]:UL:SRS:TRComb....110

CONFigure[:LTE]:UL:SRS:BHOP <Bandwidth>

This command defines the frequency hopping bandwidth b_{hop}.

Parameters:
<Bandwidth> <numeric value>
*RST: 0

Example: `CONF:UL:SRS:BHOP 1`
Sets the frequency hopping bandwidth to 1.

Manual operation: See " Hopping BW b_hop" on page 43

CONFigure[:LTE]:UL:SRS:BSRS <Bandwidth>

This command defines the bandwidth of the SRS (B_{SRS}).

Parameters:

<Bandwidth> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:BSRS 1`
Sets the SRS bandwidth to 1.

Manual operation: See " SRS Bandwidth B_SRS" on page 43

CONFigure[:LTE]:UL:SRS:CSRS <Configuration>

This command defines the SRS bandwidth configuration (C_{SRS}).

Parameters:

<Configuration> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:CSRS 2`
Sets the SRS bandwidth configuration to 2.

Manual operation: See " SRS BW Conf. C_SRS" on page 44

CONFigure[:LTE]:UL:SRS:CYCS <CyclicShift>

Sets the cyclic shift n_CS used for the generation of the sounding reference signal CAZAC sequence.

Parameters:

<CyclicShift> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:CYCS 2`
Sets the cyclic shift to 2.

Manual operation: See " SRS Cyclic Shift N_CS" on page 44

CONFigure[:LTE]:UL:SRS:ISRS <ConfIndex>

This command defines the SRS configuration index (I_{SRS}).

Parameters:

<ConfIndex> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:ISRS 1`
Sets the configuration index to 1.

Manual operation: See " Conf. Index I_SRS" on page 44

CONFigure[:LTE]:UL:SRS:MUPT <State>

This command turns SRS MaxUpPts on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "SRS MaxUpPts" on page 43

CONFigure[:LTE]:UL:SRS:NRRC <FreqDomPos>

Sets the UE specific parameter Freq. Domain Position n_{RRC}.

Parameters:
<FreqDomPos> <numeric value>
*RST: 0

Example: `CONF:UL:SRS:NRRC 1`
Sets n_{RRC} to 1.

Manual operation: See " Freq. Domain Pos. n_RRC" on page 44

CONFigure[:LTE]:UL:SRS:POWer <Power>

Defines the relative power of the sounding reference signal.

Parameters:
<Power> <numeric value>
*RST: 0
Default unit: DB

Example: `CONF:UL:SRS:POW -1.2`
Sets the power to -1.2 dB.

Manual operation: See " SRS Rel Power" on page 44

CONFigure[:LTE]:UL:SRS:STAT <State>

Activates or deactivates the sounding reference signal.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CONF:UL:SRS:STAT ON`
Activates the sounding reference signal.

Manual operation: See " Present" on page 42

CONFigure[:LTE]:UL:SRS:SUConfig <Configuration>

This command defines the SRS subframe configuration.

Parameters:

<Configuration> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:SUC 4`
Sets SRS subframe configuration to 4.

Manual operation: See " SRS Subframe Conf." on page 43

CONFigure[:LTE]:UL:SRS:TRComb <TransComb>

This command defines the transmission comb (k_{TC}).

Parameters:

<TransComb> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:TRC 1`
Sets transmission comb to 1.

Manual operation: See " Transm. Comb. k_TC" on page 44

PUSCH Structure

CONFigure[:LTE]:UL:PUSCh:FHMode....110
CONFigure[:LTE]:UL:PUSCh:FHOFfset....111
CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB....111
CONFigure[:LTE]:UL:PUSCh:NOSM....111

CONFigure[:LTE]:UL:PUSCh:FHMode <HoppingMode>

This command selects the frequency hopping mode in the PUSCH structure.

Parameters:

<HoppingMode> **NONE**
No hopping

INTer
Inter subframe hopping

INTRa
Intra subframe hopping

*RST: NONE

Example: `CONF:UL:PUSC:FHM NONE`
Deactivates frequency hopping for the PUSCH.

Manual operation: See " Frequency Hopping Mode" on page 45

CONFigure[:LTE]:UL:PUSCh:FHOFfset <Offset>

This command defines the frequency hopping offset for the PUSCH.

Parameters:

<Offset> <numeric value>
*RST: 4

Example: `CONF:UL:PUSC:FHOF 5`
Sets the hopping offset to 5.

Manual operation: See " PUSCH Hopping Offset" on page 46

CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB <HBInfo>

This command defines the information in hopping bits of the PUSCH.

Parameters:

<HBInfo> <numeric value>
Range: 0 to 3
*RST: 0

Example: `CONF:UL:PUSC:FHOP:IIHB 1`
Defines type 1 as the information in hopping bits.

Manual operation: See " Info. in Hopping Bits" on page 46

CONFigure[:LTE]:UL:PUSCh:NOSM <NofSubbands>

This command defines the number of subbands/M of the PUSCH.

Parameters:

<NofSubbands> <numeric value>
*RST: 4

Example: `CONF:UL:PUSC:NOSM 2`
Sets the number of subbands to 2.

Manual operation: See " Number of Subbands" on page 45

PUCCH Structure

CONFigure[:LTE]:UL:PUCCh:DESHift....111
CONFigure[:LTE]:UL:PUCCh:FORMat....112
CONFigure[:LTE]:UL:PUCCh:N1CS....112
CONFigure[:LTE]:UL:PUCCh:N2RB....112
CONFigure[:LTE]:UL:PUCCh:NORB....113
CONFigure[:LTE]:UL:PUCCh:NPAR....113

CONFigure[:LTE]:UL:PUCCh:DESHift <Shift>

This command defines the delta shift of the PUCCH.

Parameters:

<Shift> <numeric value>

Range: 1 to 3
*RST: 2

Example: `CONF:UL:PUCC:DESH 3`
Sets the delta shift of the PUCCH to 3.

Manual operation: See " Delta Shift" on page 47

CONFigure[:LTE]:UL:PUCCh:FORMat <Format>

This command selects the PUCCH format.

Note that formats 2a and 2b are available for normal cyclic prefix length only.

Parameters:

<Format> **F1 (F1)**
F1A (F1a)
F1B (F1b)
F2 (F2)
F2A (F2a)
F2B (F2b)
F3 (F3)
*RST: F1N

Example: `CONF:UL:PUCC:FORM F1N`
Sets the PUCCH format to F1 normal.

Manual operation: See " Format" on page 47

CONFigure[:LTE]:UL:PUCCh:N1CS <N1cs>

This command defines the N(1)_cs of the PUCCH.

Parameters:

<N1cs> <numeric value>

*RST: 6

Example: `CONF:UL:PUCC:N1CS 4`
Sets N(1)_cs to 4.

Manual operation: See " N(1)_cs" on page 47

CONFigure[:LTE]:UL:PUCCh:N2RB <N2RB>

This command defines the N(2)_RB of the PUCCH.

Parameters:

<N2RB> <numeric value>

*RST: 1

Example: `CONF:UL:PUCC:N2RB 2`
Sets N2_RB to 2.

Manual operation: See " N(2)_RB" on page 47

CONFigure[:LTE]:UL:PUCCh:NORB <ResourceBlocks>

This command selects the number of resource blocks for the PUCCH.

Parameters:
<ResourceBlocks> <numeric value>
*RST: 0

Example: `CONF:UL:PUCC:NORB 6`
Sets the number of resource blocks to 6.

Manual operation: See " No. of RBs for PUCCH" on page 46

CONFigure[:LTE]:UL:PUCCh:NPAR <NPUCCH>

This command defines the N_PUCCH parameter in the PUCCH structure settings.

Parameters:
<NPUCCH> <numeric value>
<numeric value>
SUBF
Selects the definition of N_PUCCH on subframe level.
*RST: 0

Example: `CONF:UL:PUCC:NPAR 2`
Sets N_PUCCH to 2.

Manual operation: See " N_PUCCH" on page 48

PRACH Structure

CONFigure[:LTE]:UL:PRACh:APM....113
CONFigure[:LTE]:UL:PRACh:CONF....114
CONFigure[:LTE]:UL:PRACh:FOFFset....114
CONFigure[:LTE]:UL:PRACh:FRINdex....114
CONFigure[:LTE]:UL:PRACh:HFINdicator....114
CONFigure[:LTE]:UL:PRACh:NCSC....115
CONFigure[:LTE]:UL:PRACh:RSEQ....115
CONFigure[:LTE]:UL:PRACh:RSET....115
CONFigure[:LTE]:UL:PRACh:SINDex....115

CONFigure[:LTE]:UL:PRACh:APM <State>

This command turns automatic preamble mapping for the PRACH on and off.

Parameters:
<State> ON | OFF

Example: `CONF:UL:PRAC:APM ON`
Turns automatic preamble mapping on.

Manual operation: See "PRACH Preamble Mapping" on page 49

CONFigure[:LTE]:UL:PRACh:CONF <Configuration>

This command selects the PRACH preamble format.

Parameters:
<Configuration> <numeric value>

Example: `CONF:UL:PRAC:CONF 2`
Selects PRACH configuration 2.

Manual operation: See "PRACH Configuration" on page 48

CONFigure[:LTE]:UL:PRACh:FOFFset <Offset>

This command defines the PRACH frequency offset.

The command is available for preamble formats 0 to 3.

Parameters:
<Offset> Resource block offset.

Example: `CONF:UL:PRAC:FOFF 5`
Defines a frequency offset of 5 resource blocks.

Manual operation: See "Frequency Offset" on page 49

CONFigure[:LTE]:UL:PRACh:FRINdex <FRINdex>

This command selects the PRACH frequency index.

Parameters:
<FRINdex> <numeric value>

Example: `CONF:UL:PRAC:FRIN 10`
Selects the frequency index 10.

Manual operation: See "PRACH Preamble Mapping" on page 49

CONFigure[:LTE]:UL:PRACh:HFINdicator <HFINdicator>

This command defines the PRACH half frame indicator.

Parameters:
<HFINdicator> <numeric value>

Example: `CONF:UL:PRAC:HFIN 5`
Selects half frame indicator 5.

Manual operation: See "PRACH Preamble Mapping" on page 49

CONFigure[:LTE]:UL:PRACh:NCSC <Configuration>

This command defines the Ncs configuration for the PRACH.

Parameters:
<Configuration> <numeric value>

Example: `CONF:UL:PRAC:NCSC 1`
Selects Ncs configuration 1.

Manual operation: See "Ncs Conf" on page 49

CONFigure[:LTE]:UL:PRACh:RSEQ <RootSeqIdx>

This command defines the PRACH logical root sequence index.

Parameters:
<RootSeqIdx> <numeric value>

Example: `CONF:UL:PRAC:RSEQ 2`
Selects logical root sequence index 2.

Manual operation: See "Logical Root Sequ. Idx" on page 49

CONFigure[:LTE]:UL:PRACh:RSET <State>

This command turns the restricted preamble set for PRACH on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `CONF:UL:PRAC:RSET ON`
Turns the restricted set on.

Manual operation: See "Restricted Set" on page 49

CONFigure[:LTE]:UL:PRACh:SINDex <Index>

This command selects the PRACH sequence index.

Parameters:
<Index> **<IndexValue>**
Number that defines the index manually.
AUTO
Automatcailly determines the index.

Example: `CONF:UL:PRAC:SIND 2`
Selects sequence index 2.

Manual operation: See "Sequence Index (v)" on page 49

6.7.2.2 Input / Frontend

Defining the Frequency

[SENSe]:FREQuency:CENTer....116
[SENSe:]FREQuency:CENTer:STEP....116
[SENSe:]FREQuency:CENTer:STEP:LINK....116
[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor....117
[SENSe:]FREQuency:OFFSet....117

[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: `FREQ:CENT 2GHZ`
Set the center frequency to 2 GHz.

Manual operation: See "Defining the Signal Frequency" on page 50

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` and `SENS:FREQ DOWN` commands, see `[SENSe]:FREQuency:CENTer` on page 116.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Defining the Signal Frequency" on page 50

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType>

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

OFF
Decouples the step size.

*RST: SPAN

Example:
```
FREQ:CENT:STEP:LINK SPAN
```

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

Parameters:

<Factor>

1 to 100 PCT

*RST: 10

Example:
```
FREQ:CENT:STEP:LINK:FACT 20PCT
```

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Parameters:

<Offset>

Range: -100 GHz to 100 GHz
*RST: 0 Hz

Example:
```
FREQ:OFFS 1GHZ
```

Usage: SCPI confirmed

Manual operation: See "Defining the Signal Frequency" on page 50

Configuring the Vertical Axis

CALCulate<n>:UNIT:POWer....118
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel....118
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet....118
INPut:ATTenuation....118
INPut:ATTenuation:AUTO....119
INPut:COUPling....119
INPut:GAIN[:VALue]....119
INPut:GAIN:STATe....120
INPut:IMPedance....120
INPut<n>:EATT....121
INPut<n>:EATT:AUTO....121
INPut<n>:EATT:STATe....121
[SENSe:]ADJust:LEVel....122

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all measurement windows.

Parameters:

<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

Manual operation: See "Defining a Reference Level" on page 51

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level.

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Defining a Reference Level" on page 51

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset.

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Defining a Reference Level" on page 51

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuating the Signal" on page 52

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State> ON | OFF
*RST: ON

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuating the Signal" on page 52

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP:DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 53

INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 120).

The command requires option R&S FSW-B24.

Parameters:

<Gain> 15 dB | 30 dB

The availability of preamplification levels depends on the R&S FSW model.
- R&S FSW8: 15dB and 30 dB
- R&S FSW13: 15dB and 30 dB
- R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.

*RST: OFF

Example: `INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier (option B24)" on page 53

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

The command requires option R&S FSW-B24.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Preamplifier (option B24)" on page 53

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 53

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<Attenuation> Attenuation level in dB.

Default unit: dB

Example: `INP:EATT 10`

Defines an attenuation level of 10 dB.

Manual operation: See "Attenuating the Signal" on page 52

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:AUTO ON`

Turns automatic selection of electronic attenuation level on.

Manual operation: See "Attenuating the Signal" on page 52

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with option R&S FSW-B25, but not if R&S FSW-B17 is active.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`

Turns the electronic attenuator on.

Manual operation: See "Attenuating the Signal" on page 52

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSW or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Defining a Reference Level" on page 51

6.7.2.3 Signal Capture

Data Capture

[SENSe][:LTE]:FRAMe:COUNt....122
[SENSe][:LTE]:FRAMe:COUNt:STATe....122
[SENSe][:LTE]:FRAMe:COUNt:AUTO....123
[SENSe]:SWAPiq....123
[SENSe]:SWEep:TIME....123

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example: `FRAM:COUN:STAT ON`
Activates manual input of frames to be analyzed.
`FRAM:COUN 20`
Analyzes 20 frames.

Manual operation: See "Number of Frames to Analyze" on page 55

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State> **ON**
You can set the number of frames to analyze.

OFF
The R&S FSW analyzes a single sweep.

*RST: ON

Example: `FRAM:COUN:STAT ON`
Turns manual setting of number of frames to analyze on.

Manual operation: See "Overall Frame Count" on page 54

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>
ON
Selects the number of frames to analyze according to the LTE standard.
OFF
Turns manual selection of the frame number on.

Example: `FRAM:COUN:AUTO ON`
Turns automatic selection of the analyzed frames on.

Manual operation: See "Auto According to Standard" on page 55

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State>
ON | OFF
*RST: OFF

Example: `SWAP ON`
Turns a swap of the I and Q branches on.

Manual operation: See "Swap I/Q" on page 55

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength>
Numeric value in seconds.
Default unit: s

Example: `SWE:TIME 40`
Defines a capture time of 40 seconds.

Manual operation: See "Capture Time" on page 54

Trigger

The trigger functionality of the LTE measurement application is the same as that of the R&S FSW.

For a comprehensive description of the available remote control commands for trigger configuration see the documentation of the R&S FSW.

6.7.2.4 Demodulation

[SENSe][:LTE]:UL:DEMod:MODE 124
[SENSe][:LTE]:UL:DEMod:CESTimation 124
[SENSe][:LTE]:UL:DEMod:EEPeriod 124
[SENSe][:LTE]:UL:DEMod:CDCoffset 125
[SENSe][:LTE]:UL:DEMod:CBSCrambling 125
[SENSe][:LTE]:UL:DEMod:SISYnc 125
[SENSe][:LTE]:UL:DEMod:MCFilter 125

[SENSe][:LTE]:UL:DEMod:MODE <Reference>

This command selects the uplink analysis mode.

Parameters:

<Reference>

PUSCh
Analyzes the PUSCH and PUCCH.

PRACh
Analyzes the PRACH.

*RST: PUSCh

Example: `UL:DEM:MODE PRAC`
Selects PRACH analysis mode.

Manual operation: See "Analysis Mode" on page 57

[SENSe][:LTE]:UL:DEMod:CESTimation <Type>

This command selects the channel estimation type for uplink signals.

Parameters:

<Type> PIL | PILPAY

PIL
Pilot only

PILP
Pilot and payload

*RST: PILP

Example: `UL:DEM:CEST PIL`
Uses only the pilot signal for channel estimation.

Manual operation: See "Channel Estimation Range" on page 57

[SENSe][:LTE]:UL:DEMod:EEPeriod <State>

This command includes or excludes the exclusion period from EVM results.

Parameters:
<State> ON | OFF

Example: `UL:DEM:EEP ON`
Turns the exclusion periods for EVM calculation on.

Manual operation: See "EVM with Exclusion Period" on page 57

[SENSe][:LTE]:UL:DEMod:CDCoffset <State>

This command turns DC offset compensation for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `UL:DEM:CDC OFF`
Deactivates DC offset compensation.

Manual operation: See "Compensate DC Offset" on page 58

[SENSe][:LTE]:UL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `UL:DEM:CBSC OFF`
Deactivates the scrambling.

Manual operation: See "Scrambling of Coded Bits" on page 58

[SENSe][:LTE]:UL:DEMod:SISYnc <State>

This command turns suppressed interference synchronization on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `UL:DEM:SISY ON`
Turns suppressed interference synchronization on.

Manual operation: See "Suppressed Interference Synchronization" on page 58

[SENSe][:LTE]:UL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:
<State> ON | OFF
*RST: OFF

Example: `UL:DEM:MCF ON`
Turns suppression on of neighboring carriers on.

Manual operation: See "Multicarrier Filter" on page 58

6.7.2.5 Tracking

[SENSe][:LTE]:UL:TRACking:PHASe....126
[SENSe][:LTE]:UL:TRACking:TIME....126

[SENSe][:LTE]:UL:TRACking:PHASe <Type>

This command selects the phase tracking type for uplink signals.

Parameters:
<Type> **OFF**
Deactivate phase tracking
PIL
Pilot only
PILP
Pilot and payload
*RST: OFF

Example: `SENS:UL:TRAC:PHAS PILP`
Use pilots and payload for channel estimation.

Manual operation: See "Phase" on page 56

[SENSe][:LTE]:UL:TRACking:TIME <State>

This command turns timing tracking for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `UL:TRAC:TIME ON`
Activates timing tracking.

Manual operation: See "Timing" on page 56

6.7.3 Configuring Frequency Sweep Measurements

Please refer to the documentation of the R&S FSW base unit for a comprehensive list and description of remote commands necessary to configure and perform frequency sweep measurements (ACLR and SEM).

All commands specific to the LTE application are listed below.

[SENSe]:POWer:ACHannel:AACHannel.....127
[SENSe]:POWer:SEM:UL:REQuirement.....127

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel>

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example:

```
POW:ACH:AACH UTRA384
```

Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

Manual operation: See "Assumed Adjacent Channel Carrier" on page 59

[SENSe]:POWer:SEM:UL:REQuirement <Requirement>

This command selects the requirements for a spectrum emission mask.

Parameters:

<Requirement> GEN | NS3 | NS4 | NS67

GEN
General spectrum emission mask.

NS3 | NS4 | NS67
Spectrum emission masks with additional requirements.

Example:

```
POW:SEM:UL:REQ NS3
```

Selects a spectrum emission mask with requirement for network signalled value NS3.

Manual operation: See "SEM Requirement" on page 60

6.8 Analysis

- Evaluation Range....128
- Y-Axis Scale....129
- Result Settings....130

6.8.1 Evaluation Range

[SENSe][:LTE]:PREamble:SELect....128
[SENSe][:LTE]:SLOT:SELect....128
[SENSe][:LTE]:SUBFrame:SELect....129

[SENSe][:LTE]:PREamble:SELect <Subframe>

This command selects a particular preamble for measurements that analyze individual preambles.

The command is available in PRACH analysis mode.

Parameters:

<Subframe>

ALL
Analyzes all preambles.

<numeric value>
Selects the premable to analyze.

*RST: ALL

Example:

```
PRE:SEL ALL
```

Analyzes all preambles.

Manual operation: See "Preamble Selection" on page 62

[SENSe][:LTE]:SLOT:SELect <Slot>

This command selects the slot to analyze.

Parameters:

<Slot>

S0
Slot 0

S1
Slot 1

ALL
Both slots

*RST: ALL

Example:

```
SLOT:SEL S1
```

Selects slot 1 for analysis.

Manual operation: See "Slot Selection" on page 62

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: `SUBF:SEL ALL`
Select all subframes for analysis.

Manual operation: See "Subframe Selection" on page 61

6.8.2 Y-Axis Scale

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE....129
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum....129
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum....129

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again.

Usage: SCPI confirmed

Manual operation: See "Y-Axis Scale" on page 63

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value of the y-axis for the selected result display.

Parameters:

<Value> <numeric value>

*RST: depends on the result display
The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Y-Axis Scale" on page 63

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum <Value>

This command defines the minimum value of the y-axis for the selected result display.

Parameters:

<Value> <numeric value>

*RST: depends on the result display
The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Y-Axis Scale" on page 63

6.8.3 Result Settings

UNIT:BSTR....130
UNIT:EVM....130

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>

SYMbols
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example:
```
UNIT:BSTR BIT
```
Bit stream gets displayed using Bits.

Manual operation: See "Bit Stream Format" on page 64

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example:
```
UNIT:EVM PCT
```
EVM results to be returned in %.

Manual operation: See "EVM Unit" on page 64

6.9 General Window Commands

The following commands are required to configure general window layout, independant of the application.

DISPlay:FORMat....131
DISPlay[:WINDow<n>]:SIZE....131

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SPL

Example:

```
DISP:FORM SING
```

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 135).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example:

```
DISP:WIND2:LARG
```

6.10 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]?....132
LAYout:CATalog[:WINDow]?....133
LAYout:IDENtify[:WINDow]?....134
LAYout:REMove[:WINDow]....134
LAYout:REPLace[:WINDow]....134
LAYout:SPLitter....135
LAYout:WINDow<n>:ADD?....136
LAYout:WINDow<n>:IDENtify?....137
LAYout:WINDow<n>:REMove....137
LAYout:WINDow<n>:REPLace....137

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow
Direction the new window is added relative to the existing window.

<WindowType> text value
Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:ADD? '1',LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation:
See "Capture Buffer" on page 9
See "EVM vs Carrier" on page 10
See "EVM vs Symbol" on page 11
See "EVM vs Subframe" on page 12
See "Power Spectrum" on page 12
See "Inband Emission" on page 13
See "Channel Flatness" on page 14
See "Channel Flatness SRS" on page 14
See "Channel Group Delay" on page 15
See "Channel Flatness Difference" on page 15
See "Constellation Diagram" on page 16
See "CCDF" on page 16
See "Allocation Summary" on page 17
See "Bit Stream" on page 17
See "Result Summary" on page 18
See "Marker Table" on page 21

Table 6-2: <WindowType> parameter values for LTE Uplink Measurement application

Parameter value	Window type
ASUM	Allocation Summary
BSTR	Bitstream
CBUF	Capture Buffer
CCDF	CCDF
FLAT	Channel Flatness
FSRS	Channel Flatness SRS
CONS	Constellation Diagram
EVCA	EVM vs Carrier
EVSU	EVM vs Subframe
EVSY	EVM vs Symbol
FEVS	Frequency Error vs Symbol
GDEL	Group Delay
IE	Inband Emission
IEA	Inband Emission All
MTAB	Marker Table
PSPE	Power Spectrum
RSUM	Result Summary

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 132 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

As opposed to the `DISPlay[:WINDow<n>]:SIZE` on page 131 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

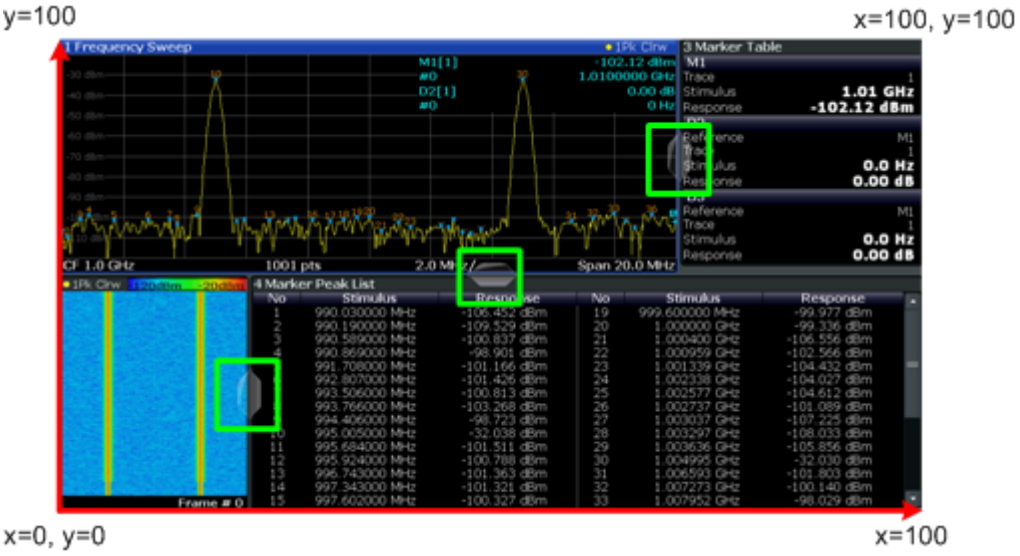


Fig. 6-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu). The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 6-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 132 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix).

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>).

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 132 for a list of available window types.

List of Commands

ABORt....74
CALCulate<n>:DELTamarker<m>:X....96
CALCulate<n>:DELTamarker<m>:Y?....97
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?....87
CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?....88
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?....88
CALCulate<n>:MARKer<m>:X....97
CALCulate<n>:MARKer<m>:Y?....97
CALCulate<n>:UNIT:POWer....118
CONFigure[:LTE]:DUPLexing....99
CONFigure[:LTE]:LDIRection....100
CONFigure[:LTE]:MEASurement....98
CONFigure[:LTE]:UL:BW....100
CONFigure[:LTE]:UL:CSUBframes....103
CONFigure[:LTE]:UL:CYCPrefix....100
CONFigure[:LTE]:UL:DRS:DSSHift....107
CONFigure[:LTE]:UL:DRS:GRPHopping....106
CONFigure[:LTE]:UL:DRS:NDMRs....107
CONFigure[:LTE]:UL:DRS:PUCCh:POWer....106
CONFigure[:LTE]:UL:DRS:SEQHopping....106
CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer....106
CONFigure[:LTE]:UL:PLC:CID....101
CONFigure[:LTE]:UL:PLC:CIDGroup....101
CONFigure[:LTE]:UL:PLC:PLID....101
CONFigure[:LTE]:UL:PRACh:APM....113
CONFigure[:LTE]:UL:PRACh:CONF....114
CONFigure[:LTE]:UL:PRACh:FOFFset....114
CONFigure[:LTE]:UL:PRACh:FRINdex....114
CONFigure[:LTE]:UL:PRACh:HFINdicator....114
CONFigure[:LTE]:UL:PRACh:NCSC....115
CONFigure[:LTE]:UL:PRACh:RSEQ....115
CONFigure[:LTE]:UL:PRACh:RSET....115
CONFigure[:LTE]:UL:PRACh:SINDex....115
CONFigure[:LTE]:UL:PUCCh:DESHift....111
CONFigure[:LTE]:UL:PUCCh:FORMat....112
CONFigure[:LTE]:UL:PUCCh:N1CS....112
CONFigure[:LTE]:UL:PUCCh:N2RB....112
CONFigure[:LTE]:UL:PUCCh:NORB....113
CONFigure[:LTE]:UL:PUCCh:NPAR....113
CONFigure[:LTE]:UL:PUSCh:FHMode....110
CONFigure[:LTE]:UL:PUSCh:FHOFfset....111
CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB....111
CONFigure[:LTE]:UL:PUSCh:NOSM....111
CONFigure[:LTE]:UL:SFNO....105
CONFigure[:LTE]:UL:SRS:BHOP....107

CONFigure[:LTE]:UL:SRS:BSRS....108
CONFigure[:LTE]:UL:SRS:CSRS....108
CONFigure[:LTE]:UL:SRS:CYCS....108
CONFigure[:LTE]:UL:SRS:ISRS....108
CONFigure[:LTE]:UL:SRS:MUPT....109
CONFigure[:LTE]:UL:SRS:NRRC....109
CONFigure[:LTE]:UL:SRS:POWer....109
CONFigure[:LTE]:UL:SRS:STAT....109
CONFigure[:LTE]:UL:SRS:SUConfig....110
CONFigure[:LTE]:UL:SRS:TRComb....110
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT....103
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation....103
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount....104
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset....104
CONFigure[:LTE]:UL:TDD:SPSC....102
CONFigure[:LTE]:UL:TDD:UDConf....102
CONFigure[:LTE]:UL:UEID....105
DISPlay:FORMat....131
DISPlay[:WINDow<n>]:SIZE....131
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:AUTO ONCE....129
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum....129
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum....129
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel....118
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet....118
FETCh:SUMMary:CRESt[:AVERage]?....92
FETCh:SUMMary:EVM:PCHannel:MAXimum?....93
FETCh:SUMMary:EVM:PCHannel:MINimum?....93
FETCh:SUMMary:EVM:PCHannel[:AVERage]?....93
FETCh:SUMMary:EVM:PSIGnal:MAXimum?....93
FETCh:SUMMary:EVM:PSIGnal:MINimum?....93
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?....93
FETCh:SUMMary:EVM:SDQP[:AVERage]?....90
FETCh:SUMMary:EVM:SDST[:AVERage]?....90
FETCh:SUMMary:EVM:UCCD[:AVERage]?....90
FETCh:SUMMary:EVM:UCCH[:AVERage]?....91
FETCh:SUMMary:EVM:UPRA[:AVERage]?....91
FETCh:SUMMary:EVM:USQP[:AVERage]?....91
FETCh:SUMMary:EVM:USST[:AVERage]?....92
FETCh:SUMMary:EVM[:ALL]:MAXimum?....93
FETCh:SUMMary:EVM[:ALL]:MINimum?....93
FETCh:SUMMary:EVM[:ALL][:AVERage]?....93
FETCh:SUMMary:FERRor:MAXimum?....94
FETCh:SUMMary:FERRor:MINimum?....94
FETCh:SUMMary:FERRor[:AVERage]?....94
FETCh:SUMMary:GIMBalance:MAXimum?....94
FETCh:SUMMary:GIMBalance:MINimum?....94
FETCh:SUMMary:GIMBalance[:AVERage]?....94
FETCh:SUMMary:IQOFfset:MAXimum?....95

FETCh:SUMMary:IQOFfset:MINimum?....95
FETCh:SUMMary:IQOFfset[:AVERage]?....95
FETCh:SUMMary:POWer:MAXimum?....95
FETCh:SUMMary:POWer:MINimum?....95
FETCh:SUMMary:POWer[:AVERage]?....95
FETCh:SUMMary:QUADerror:MAXimum?....95
FETCh:SUMMary:QUADerror:MINimum?....95
FETCh:SUMMary:QUADerror[:AVERage]?....95
FETCh:SUMMary:SERRor:MAXimum?....96
FETCh:SUMMary:SERRor:MINimum?....96
FETCh:SUMMary:SERRor[:AVERage]?....96
FETCh:SUMMary:TFRame?....96
FORMat[:DATA]....89
INITiate:CONTinuous....75
INITiate:SEQuencer:ABORt....76
INITiate:SEQuencer:IMMediate....76
INITiate:SEQuencer:MODE....77
INITiate[:IMMediate]....75
INPut:ATTenuation....118
INPut:ATTenuation:AUTO....119
INPut:COUPling....119
INPut:GAIN:STATe....120
INPut:GAIN[:VALue]....119
INPut:IMPedance....120
INPut<n>:EATT....121
INPut<n>:EATT:AUTO....121
INPut<n>:EATT:STATe....121
INSTrument:CREate:DUPLicate....71
INSTrument:CREate:REPLace....71
INSTrument:CREate[:NEW]....71
INSTrument:DELete....72
INSTrument:LIST?....72
INSTrument:REName....73
INSTrument[:SELect]....73
LAYout:ADD[:WINDow]?....132
LAYout:CATalog[:WINDow]?....133
LAYout:IDENtify[:WINDow]?....134
LAYout:REMove[:WINDow]....134
LAYout:REPLace[:WINDow]....134
LAYout:SPLitter....135
LAYout:WINDow<n>:ADD?....136
LAYout:WINDow<n>:IDENtify?....137
LAYout:WINDow<n>:REMove....137
LAYout:WINDow<n>:REPLace....137
SYSTem:PRESet:CHANnel[:EXECute]....99
SYSTem:SEQuencer....78
TRACe<n>[:DATA]?....87
UNIT:BSTR....130

UNIT:EVM....130
[SENSe:]ADJust:LEVel....122
[SENSe:]FREQuency:CENTer:STEP....116
[SENSe:]FREQuency:CENTer:STEP:LINK....116
[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor....117
[SENSe:]FREQuency:OFFSet....117
[SENSe]:FREQuency:CENTer....116
[SENSe]:POWer:ACHannel:AACHannel....127
[SENSe]:POWer:SEM:UL:REQuirement....127
[SENSe]:SWAPiq....123
[SENSe]:SWEep:TIME....123
[SENSe]:SYNC[:STATe]?....76
[SENSe][:LTE]:FRAMe:COUNt....122
[SENSe][:LTE]:FRAMe:COUNt:AUTO....123
[SENSe][:LTE]:FRAMe:COUNt:STATe....122
[SENSe][:LTE]:PREamble:SELect....128
[SENSe][:LTE]:SFLatness:ECONditions....102
[SENSe][:LTE]:SFLatness:OBANd....102
[SENSe][:LTE]:SLOT:SELect....128
[SENSe][:LTE]:SUBFrame:SELect....129
[SENSe][:LTE]:UL:DEMod:ACON....104
[SENSe][:LTE]:UL:DEMod:CBSCrambling....125
[SENSe][:LTE]:UL:DEMod:CDCoffset....125
[SENSe][:LTE]:UL:DEMod:CESTimation....124
[SENSe][:LTE]:UL:DEMod:EEPeriod....124
[SENSe][:LTE]:UL:DEMod:MCFilter....125
[SENSe][:LTE]:UL:DEMod:MODE....124
[SENSe][:LTE]:UL:DEMod:SISYnc....125
[SENSe][:LTE]:UL:FORMat:SCD....105
[SENSe][:LTE]:UL:TRACking:PHASe....126
[SENSe][:LTE]:UL:TRACking:TIME....126

Index

A

AC/DC coupling 53
ACLR 21
Allocation summary 17
Auto Demodulation 38
Auto Detection (Cell Identity) 36

B

Bit stream 17

C

Capture buffer 9
Capture Time 54
CCDF 16
Cell ID 36
Cell Identity Group 36
Channel Bandwidth 34
Channel Estimation Range 57
Channel flatness 14
Channel flatness difference 15
Channel flatness group delay 15
Channel flatness SRS 14
Compensate DC Offset 58
Configurable Subframes 37
Configuration Table 37
Constellation diagram 16
Constellation Selection 62
Copying
  Measurement channel (remote) 71
Coupling
  Input (remote) 119

D

Demodulation Reference Signal
  Delta Sequence Shift 42
  Group Hopping 41
  n_DRMS 42
  Relative Power PUCCH 41
  Relative Power PUSCH 41
  Sequence 41
  Sequence Hopping 41
Duplicating
  Measurement channel (remote) 71

E

Evaluation methods
  Remote 132
EVM vs Carrier 10
EVM vs subframe 12
EVM vs symbol 11
External Attenuation 52

F

Frame Number Offset 37
Frequency 50

H

Hardware settings
  Displayed 6

I

Identity (Physical Layer) 36
Impedance
  Remote 120
  Setting 53
Inband emission 13
Input
  Coupling 53
  Coupling (remote) 119
Installation 5

M

Markers
  Querying position (remote) 97
  Table (evaluation method) 21
Marker table
  Evaluation method 21
Maximizing
  Windows (remote) 131
Measurement
  ACLR 21
  allocation summary 17
  bit stream 17
  capture buffer 9
  CCDF 16
  channel flatness 14
  channel flatness difference 15
  channel flatness grdel 15
  channel flatness SRS 14
  constellation 16
  EVM vs carrier 10
  EVM vs subframe 12
  EVM vs symbol 11
  inband emission 13
  numerical 18
  power spectrum 12
  result summary 18
  spectrum mask 22
Measurement channel
  Creating (remote) 71
  Deleting (remote) 72
  Duplicating (remote) 71
  Querying (remote) 72
  Renaming (remote) 73
  Replacing (remote) 71
Multicarrier filter 58

N

Number of RB 34
Numerical results 18

O

Options
  Preamplifier (B24) 53

P

Phase Error ... 56
Power spectrum ... 12
Preamplifier
  Setting ... 53
  Softkey ... 53
Presetting
  Channels ... 31
PUCCH Structure
  Delta Shift ... 47
  Format ... 47
  N_PUCCH ... 48
  N(1)_cs ... 47
  N(2)_RB ... 47
  Number of RBs for PUCCH ... 46
PUSCH Structure
  Frequency Hopping Mode ... 45
  Info. in Hopping Bits ... 46
  Number of Subbands ... 45
  PUSCH Hopping Offset ... 46

R

Reference Level ... 51
Remote commands
  Basics on syntax ... 66
  Boolean values ... 69
  Capitalization ... 67
  Character data ... 70
  Data blocks ... 70
  Numeric values ... 68
  Optional keywords ... 67
  Parameters ... 68
  Strings ... 70
  Suffixes ... 67
Resource Blocks ... 34
Restoring
  Channel settings ... 31
Result Display
  Constellation Selection ... 62
Result displays
  Marker table ... 21
Result summary ... 18

S

Scrambling of coded bits ... 58
SEM requirement ... 60
Sequencer
  Aborting (remote) ... 76
  Activating (remote) ... 76
  Mode (remote) ... 77
  Remote ... 75
Settings
  Auto ... 36
  Auto Demodulation ... 38
  Capture Time ... 54
  Cell ID ... 36
  Cell Identity Group ... 36
  Channel Bandwidth ... 34
  Channel Estimation Range ... 57
  Compensate DC Offset ... 58
  Conf. Index I_SRS ... 44
  Configurable Subframes ... 37
  Delta Sequence Shift ... 42
  Delta Shift ... 47
  Ext Att ... 52
  Format ... 47
  Frame Number Offset ... 37
  Freq. Domain Pos. n_RRC ... 44
  Frequency ... 50
  Frequency Hopping Mode ... 45
  Group Hopping ... 41
  Hopping BW b_hop ... 43
  Identity ... 36
  Info. in Hopping Bits ... 46
  multicarrier filter ... 58
  n_DRMS ... 42
  N_PUCCH ... 48
  N(1)_cs ... 47
  N(2)_RB ... 47
  Number of RB ... 34
  Number of RBs for PUCCH ... 46
  Number of Subbands ... 45
  Phase ... 56
  Present ... 42
  PUSCH Hopping Offset ... 46
  Ref Level ... 51
  Relative Power PUCCH ... 41
  Relative Power PUSCH ... 41
  Rel Power ... 44
  Scrambling of coded bits ... 58
  Sequence ... 41
  Sequence Hopping ... 41
  SRS Bandwidth B_SRS ... 43
  SRS BW Conf. C_SRS ... 44
  SRS Cyclic Shift N_CS ... 44
  SRS Subframe Conf. ... 43
  Standard ... 33
  suppressed interference synchronization ... 58
  Swap I/Q ... 55
  TDD UL/DL Allocations ... 35
  Timing ... 56
  Transm. Comb. K_TC ... 44
Softkey
  Const Selection ... 62
Softkeys
  Preamp ... 53
Sounding Reference Signal
  Conf. Index I_SRS ... 44
  Freq. Domain Pos. n_RRC ... 44
  Hopping BW b_hop ... 43
  Present ... 42
  Rel Power ... 44
  SRS Bandwidth B_SRS ... 43
  SRS BW Conf. C_SRS ... 44
  SRS Cyclic Shift N_CS ... 44
  SRS Subframe Conf. ... 43
  Transm. Comb. K_TC ... 44
Specifics for
  Configuration ... 32
Spectrum mask ... 22
Standard Selection ... 33
Subframe Configuration Table ... 37
Suffixes
  Remote commands ... 67
Suppressed interference synchronization ... 58
Swap I/Q ... 55

T

TDD UL/DL Allocations ... 35
Timing Error ... 56

W

Windows
Adding (remote) 132
Closing (remote) 134
Configuring 32
Layout (remote) 135
Maximizing (remote) 131
Querying (remote) 133, 134
Replacing (remote) 134
Splitting (remote) 131
Types (remote) 132
Window title bar information 7